SS V. A. FOGG; SINKING IN THE GULF OF MEXICO ON 1 FEBRUARY 1972 WITH LOSS OF LIFE

Coast Guard
Washington, D. C.

13 September 1974

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15. Supplementary Notes

This report contains Marine Safety Recommendations M-74-37 through M-74-42.

16. Abstract

At 1240 on February 1, 1972, the tankship V.A. FOGG departed Freeport, Texas, en route to the Gulf of Mexico to clean cargo tanks that carried benzene residue. The vessel was due to arrive in Galveston, Texas, at 0200 on February 2. At approximately 1545, February 1, the V.A. FOGG suffered multiple explosions and sank. All 39 persons aboard died as a result of this casualty.

This report contains the action taken by the National Transportation Safety Board in determining the probable cause of the casualty and in making recommendations to prevent its recurrence. The report also contains the Marine Board of Investigation report and the action taken by the Commandant, U. S. Coast Guard.

The National Transportation Safety Board determines that the probable cause of the initial and subsequent explosions was the ignition of benzene vapors which were present both within the open cargo tanks and on the main deck of the tankship. The investigative record in this case does not contain sufficient information to determine the ignition source of the initial explosion. The probable source of ignition of the subsequent explosions was the heat produced from the preceding explosions.

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SS V. A. FOGG; SINKING IN THE GULF OF MEXICO
ON 1 FEBRUARY 1972 WITH LOSS OF LIFE

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NATIONAL TRANSPORTATION SAFETY BOARD
DEPARTMENT OF TRANSPORTATION
WASHINGTON, D.C. 20591

SS V. A. FOGG
GULF OF MEXICO
1 FEBRUARY 1972

ACTION BY THE NATIONAL TRANSPORTATION SAFETY BOARD

This casualty was investigated by a U. S. Coast Guard Marine Board of Investigation which convened at Galveston, Texas, on February 14, 1972. A representative of the National Transportation Safety Board observed part of the proceedings. The National Transportation Safety Board has considered only those facts in the investigative record which are pertinent to the Safety Board's statutory responsibility to determine the cause or probable cause of the casualty and to make recommendations. The Safety Board's analysis of the casualty is based on the evidence and testimony presented at the Marine Board of Investigation, and should be read in conjunction with the Marine Board's Findings of Fact.

SYNOPSIS

At 1240 on February 1, 1972, the tankship V. A. FOGG departed Freeport, Texas, en route to the Gulf of Mexico to clean cargo tanks that carried benzene residue. The vessel was due to arrive in Galveston, Texas, at 0200, on February 2. At approximately 1545, February 1, the V. A. FOGG suffered multiple explosions and sank. All 39 persons aboard died as a result of this casualty.

The National Transportation Safety Board determines that the probable cause of the initial and subsequent explosions was the ignition of benzene vapors which were present both within the open cargo tanks and on the main deck of the tankship. The investigative record in this case does not contain sufficient information to determine the ignition source of the initial explosion. The probable source of ignition of the subsequent explosions was the heat produced from the preceding explosions.

ANALYSIS

On February 1, 1972, certain hazards which might result in relatively high risks of explosion could have existed on the V. A. FOGG. The newly installed automated boiler system had failed several times; during some of these failures, flames and sparks had emanated from the stack. The cargo pumps had caused leakage into the pumproom. The deep well pumps on the main deck had occasionally operated improperly and had once caused excessive heat and sparks on the main deck. There was leakage between two cargo tanks. Cargo fumes had occasionally entered the berthing quarters through the air-conditioning system. The tank cleaning

procedures did not minimize the possibility of incendiary discharges in areas where explosive benzene vapors should have been expected to exist.

The Coast Guard has included considerable analysis in its Findings of Fact. The National Transportation Safety Board agrees with the Coast Guard that it is unlikely that hazards other than those which involved tank cleaning caused the casualty.

Explosive Vapors

As benzene cargo was discharged from the V. A. FOGG at the Phillips Petroleum Company and Dow Chemical Company terminals, air replaced the liquid benzene. The evaporation of the benzene residue which remained on the walls and bottom of the cargo tanks ensured a mixture of benzene vapor and air in the tanks. The lower and upper explosive limits of benzene vapor in air are 1.4 and 8.0 percent by volume, respectively.

Using the estimated air and water temperatures which affected the V. A. FOGG on February 1, it was determined that the benzene vapor concentration in the cargo tanks probably ranged between 5.7 and 8.0 percent. Permitting explosive vapors to remain within a cargo tank constitutes a dangerous situation which can result in an explosion whenever an ignition occurs.

Tank Cleaning Hazards

When cleaning tanks which have an uncontrolled atmosphere, i.e., which may contain vapor in excess of the lower explosive limit, all openings to other tanks not being cleaned should be securely closed. 1/ The practice on the V. A. FOGG was to open all cargo tanks before the first tank was cleaned. This permitted benzene hydrocarbon vapors to overflow onto the deck, where the benzene vapors were exposed to additional ignition sources.

The method of cleaning cargo tanks on the V. A. FOGG permitted the cargo residue to spill on deck. If the No. 2 center tank was cleaned before the explosion, benzene residue would have spilled onto the main deck forward of the amidship house, In addition, washings pumped from the wing tanks placed benzene residue on the main deck aft of the amidship house. The stern trim was 13 feet, and thus part of the residue would have remained on deck rather than flow overboard through the various scuppers.

1/ This was recommended by the International Chamber of Shipping in its September 1970 Report on Explosions in Very Large Crude Carriers.

Ignition Sources

Electrostatic sparks. Sparks from static electricity will ignite benzene vapor and air mixtures. Procedures normally used in washing cargo tanks produce an electrically charged water mist. Recent experiments indicate that in tankships, this water mist has enough charge density to produce an incendiary spark within the tank under certain conditions. Ability to produce a spark depends not only on the charge density of the mist but also on the tank dimensions, the conductivity of the probe on which the charge collects, and the position of the probe within the tank. It would be necessary to know the effect of such variables as the use of cold, fresh water, the organic zinc silicate coating on the interior surfaces of the tanks, the type of portable washing machines used in tank cleaning, and the tank ventilation procedures before an assessment could be made whether the conditions on the V. A. FOGG would have produced an incendiary spark. Also, the effect of benzene on charge density is unknown. Thus, until experiments which specifically duplicate the conditions and the tank cleaning procedures on the V. A. FOGG are performed, it cannot be stated with any certainty that an electrostatic charge could have occurred in the V. A. FOGG's No. 3 port wing tank. (The time between the ship's departure and the explosion, the location of the "red devil" pumps after the casualty, and the tank-cleaning procedures normally used on the ship indicate that workmen were in the No. 3 port tank at the time of the explosion.)

Other sources of ignition. The deep well pumps on the V. A. FOGG malfunctioned in the past. On at least one occasion, excessive heat and sparks were produced because of a misalignment of moving parts. Ungrounded equipment was commonly used to clean cargo tanks, and few precautions were taken to prevent release of incendiary sparks inside or outside the tanks during tank cleaning.

Vessel Design

As soon as one ignition occurred inside a tank, explosions would have propagated through the shattered tank. Since at least 21 of the 27 cargo tanks contained explosive benzene vapors, the fact that the covers on most of the other tanks were opened was not critical in the propagation of the explosion. As many as six tanks could have been damaged if the initial internal explosion started in a wing tank and as many as eight, if in a center tank.

The present design of tankships does not account for the explosive forces that can occur within a cargo tank. Until the combination of heat, oxygen, and fuel within the cargo tanks can be prevented, steps should be taken to control a single explosion. As a result of a pumproom explosion on the tankship GULFSTAG, the Safety Board recommended that consideration should be given in the design of tank vessels to provide for relief of

explosive forces in spaces where explosive vapors can accumulate. 2/ The Coast Guard rejected this recommendation as impractical "under the present state-of-the-art." The technical data offered in support of this rejection, however, were based not on experiments but on handbook applications. The loss of the V. A. FOGG demonstrates again the need for explosive-pressure relief systems in cargo tanks.

The present system of carrying dissimilar products in cargo tanks on consecutive voyages requires workmen to enter tanks before new cargo can be introduced. The bulk cargo tanks and transfer systems of most tankships are not designed to facilitate the cleanliness tolerances needed for non-contamination of cargoes. This is evident by the lack of smooth, uninterrupted tank interiors, by suction systems that cannot remove all the liquid from the tanks and piping within the tanks, and by the lack of reliable isolation valves operable from outside the tanks.

A better system could be devised through using disposable liners within the tanks. However, this would require that individual pumps be included for each tank and that tank internals be redesigned. Although not all explosive mixtures would be prevented, the duration and dispersal of such mixtures would be limited, and water pollution would be reduced. Other design features which could be incorporated in new and existing tank vessels to decrease the potential of explosions include more efficient suction stripping devices, remote ullage and gauge reading systems, closed venting systems, and cargo tank inerting systems.

Shipboard Training Program

Because of the various designs of tank vessels and the various sizes and locations of the cargo tanks, procedures for cleaning cargo tanks cannot be standardized for all tankships. Furthermore, the choice of a particular procedure also depends on the type of product residue in the tanks, the degree of cleanliness required before a new cargo can be received in the tank, and the time which has been allotted for cleaning the tank. Thus, for crewmembers and workmen to understand adequately the tank cleaning procedures which will be used at a particular time on a particular ship, they must receive training on the ship before tank cleaning is begun.

Because of the lack of a tank cleaning training program on the V. A. FOGG, the crewmembers were unaware that their cleaning methods included dangerous practices. Each crewmember and workman must recognize and report hazards discovered during tank cleaning; on-the-job training, although helpful, will not ensure safety.

2/ SS GULFSTAG, Fire With Loss of Life, Gulf of Mexico, 24 October 1966.

The Safety Board has stressed the need for shipboard safety meetings to reduce the hazards which can be present when cargo tanks are being cleaned. 3/ The V. A. FOGG disaster emphasizes this need.

Federal Regulation of Tank Cleaning Procedures

The Coast Guard has issued extensive procedural requirements on loading and discharging certain dangerous cargoes, but there are no Federal requirements in regard to the methods used to remove the residue of the dangerous cargoes from a ship's tanks. Thus, wide variations from safe practices are permitted. The Coast Guard should identify what it considers to be safe tank cleaning practices and should prohibit those it considers unsafe. The fact that safe tank cleaning procedures were available from sources outside the Coast Guard but were not used on the V. A. FOGG emphasizes that voluntary compliance will not suffice.

The Safety Board does not believe that the Coast Guard should issue detailed procedures to be followed by every tankship operator. Instead, Coast Guard regulations should create a frame of reference which can be used by tankship operators in selecting tank cleaning procedures and require these manuals to be available for inspection by the Coast Guard.

The Safety Board has previously discussed techniques which can be used to uncover weaknesses in vessel design or operation before construction. These techniques include Fault Tree Analysis, Failure Mode and Effect Analysis, and Gross Hazard Identification and Analysis. These methods essentially require identifying, in advance, factors involved in a certain kind of accident and evaluating alternate ways to prevent the accident from occurring. The methods can be flexibly applied to highly individualized operations. Thus, by selecting "explosion" as the accident to be avoided, it should be possible to devise a program of cargo tank cleaning which does not permit explosion. A basic safety training program should be created for shipboard use; also, safety meetings for crewmembers and workmen, as to the correct and safe method of tank cleaning to be used, should be conducted.

PROBABLE CAUSE

The National Transportation Safety Board determines that the probable cause of the initial and subsequent explosions was the ignition of benzene vapors which were present both within the open cargo tanks and on the main deck of the tankship. The investigative record in this case does not contain sufficient information to determine the ignition source of the initial explosion. The probable source of ignition of the subsequent explosions was the heat produced from the preceding explosions.

3/ M/V VENUS, St. Lawrence River, May 4, 1972.

RECOMMENDATIONS

The National Transportation Safety Board agrees with the Coast Guard Marine Board of Investigation that the Coast Guard should take an active role in the control of tank cleaning operations. The National Transportation Safety Board further recommends that the U. S. Coast Guard:

1. Conduct physical experiments to determine if the tank cleaning procedures used on the V. A. FOGG could have created an incendiary discharge as a result of the charged mist. (Recommendation M-74-37)

2. Include, in periodic Coast Guard examinations, the inspection and testing of machinery and other equipment to be used in tank cleaning operations. (Recommendation No. M-74-38)

3. Reconsider, for future approval of tank vessel design, the establishment of a provision for the relief of explosive pressures in cargo tanks where explosive vapors might be expected to accumulate. (Recommendation M-74-39)

4. Utilize systems safety techniques to:

   a. Evaluate proposed methods of tank cleaning operations before approving cargo-tank internal design features of tankships. (Recommendation M-74-40)

   b. Establish basic tank cleaning guidelines in the form of procedural regulations. (Recommendation M-74-41)

5. Require that each tankship and shoreside tankship cleaning facility have available for examination by the Coast Guard written detailed procedures for the specific tank cleaning operations. Included in such procedures should be the requirement for holding shipboard safety meetings to ensure that all participants involved in tank cleaning operations are informed as to the correct and safe method of detailed operations to be conducted. (Recommendation M-74-42)

BY THE NATIONAL TRANSPORTATION SAFETY BOARD:

Adopted this 13th day of September 1974:

John H. Reed, Chairman

Louis M. Thayer, Member

Isabel A. Burgess, Member

William R. Haley, Member

Francis H. McAdams, Member, did not participate in the adoption of this report.

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

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5943/V. A. FOGG
A-8 Bd

Commandant's Action

on

The Marine Board of Investigation convened to investigate circumstances surrounding the sinking of the SS V. A. FOGG in the Gulf of Mexico on 1 February 1972 with loss of life

1. The record of the Marine Board of Investigation convened to investigate subject casualty has been reviewed; and the record, including the Findings of Fact, Conclusions and Recommendations, is approved subject to the following comments and the final determination of the cause by the National Transportation Safety Board.

REMARKS

1. Concurring with the Marine Board of Investigation, it is considered that the most probable cause of the casualty was the ignition of explosive benzene vapors within or without the cargo tanks while the tanks were being prepared for the loading of cargo at Houston. The ignition source is unknown but could have been the lowering of a "red devil" pump into No. 3 port tank while the tank contained an electrically charged mist in the explosive range.

2. The characteristics of benzene set forth in Finding of Fact 12 and in the Conclusions document the explosive condition that existed in the cargo tanks due to the characteristics of the benzene remaining in the tanks and the fact that the ambient temperature was above the equilibrium temperature for the lower explosive limit (LEL) and below the equilibrium temperature for the upper explosive limit (UEL). In addition, it is stressed that temperatures above the equilibrium temperature for the upper explosive limit should not be considered as an assurance of safety obtained by an overly rich mixture of flammable vapors. Though not pertinent in the V. A. FOGG casualty, it is important to point out that other variables can act to create an explosive mixture in a tank expected to be overly rich. Dilution by natural or forced ventilation is one possibility and stratification of

heavy flammable vapors (benzene vapor, for example, is 2.8 times as heavy as air) is another possibility.

3. The adverse toxicological effects of aromatic hydrocarbons such as benzene and xylene are well documented in technical literature. Exposure to the vapors of aromatic hydrocarbons without adequate personnel protective equipment can render ship personnel incapable of performing tasks safely, can impair judgement, and could prove fatal if prolonged.

4. The conclusion that the boiler retrofit did not meet the intent of current directives for vessel automation because of the lack of a call bell system is incorrect. The directives permit any type of system such as the installed sound powered telephone system to fulfill this requirement.

ACTION CONCERNING THE RECOMMENDATIONS

1. The recommendation that the Coast Guard issue Death Certificates based upon an investigation of a casualty at sea by a Marine Board or investigating officer is not concurred with. We presently provide certified copies of narrative reports in which the conclusion is set forth that persons are missing and presumed dead. In addition, Marine Boards may issue a letter prior to final action on the Board report, that a certain person or persons are missing at sea and presumed dead. Such letters have been acceptable to insurance companies, lawyers and government agencies in the past.

2. The recommendation that Coppus Steam Turbine Model TFV221 on the deep well pumps of tank vessels be further studied seems to be inappropriate. The history of mechanical difficulties outlined by the Board related to the Byron-Jackson pump and the Coppus Steam Turbine unit. The difficulties encountered seem to indicate alignment problems. Insuring proper alignment is considered an operational problem and could exist with any pump-prime mover combination.

3. The recommendation that the Coast Guard undertake a review of the applicability of current directives for automation or "retrofit" of boiler combustion controls and burner management systems on older vessels is being acted on. Navigation and Vessel Inspection Circular 1-69 is continuously updated and minor changes are issued as necessary.

4. The current tank vessel regulations (46 CFR 35.30-35) speak to the prohibition of spark producing devices in the tanks, pump rooms and enclosed spaces. No change to this regulation is anticipated as the industry is fully aware of this long standing prohibition against spark producing devices.

5. The recommendation that the Coast Guard take a more active role in the timely and broad dissemination of tanker safety practices is concurred with. The publication of more timely information in the Proceedings of the Marine Safety Council and an update of current Coast Guard originated safety information will be accomplished. The Office of Merchant Marine Safety has actions underway to investigate existing standards, procedures and requirements, both private and public to determine what tank cleaning precautions are considered the minimum. These efforts will be intensified and expanded looking toward definitive requirements for ventilation, gas sampling, and personnel protective equipment. As data is developed the Coast Guard will disseminate information through our Proceedings and/or directly to the industry as deemed appropriate. The February 1973 issue of the Proceedings reprinted a part of the Interim Report of the Tanker Accident Study Committee as a reminder of safe practices to be utilized in tank cleaning and gas freeing operations.

6. The recommendation that the Coast Guard review existing lifeboat drill requirements and the compliance therewith is considered to be a part of an ongoing inspection and visit routine already established by the Office of Merchant Marine Safety. Efforts will continue to be made to insure compliance with the intent of the regulations requiring lifeboat drills on tank vessels and all other vessels required to exercise lifeboats.

7. The recommendation that the Coast Guard together with other interested government agencies and representatives of the tanker industry study the inerting, tank washing and gas freeing methods now in use in the industry is concurred with. The Coast Guard has commenced studying these problems and will, when appropriate, invite government agency representatives and industry members to participate.

8. The recommendation that the Coast Guard determine the feasibility of testing, examining and publishing an approved equipment list covering tools, hoses and devices used in tank cleaning is not concurred with. The Coast Guard does not have resources to "test, examine and approve" all such tools, hoses, equipment and devices. We have set forth regulations which require non-spark producing devices and that should be adequate. It is no use to solely approve a device - it must be properly maintained to remain "safe". It is up to vessel personnel and operators to use and provide equipment which meets the regulations and their intent. Coast Guard testing, evaluating and approving new equipment could stifle industry development of better devices and limiting use to only Coast Guard approved equipment and devices is not deemed necessary. It is noted that an R & D effort in this same area is under consideration (see remark #10).

9. The recommendation that the Coast Guard establish a new Branch in the Office of Merchant Marine Safety to be responsible for standards of tank cleaning, inerting of tanks and the testing and monitoring of tank

atmosphere is not concurred with. The structure of the office is adequate to cope with our intensified effort in this area. The existing Cargo and Hazardous Materials Division with support from our Merchant Marine Technical Division has this responsibility.

10. The recommendation that the Research and Development Program of the Coast Guard include work on tank cleaning, inerting of tanks, ignition control and tank atmosphere testing and monitoring equipment is concurred with. The Coast Guard Research and Development Program for FY 1974 includes a study of electrostatic phenomena in which a broad systematic and practical approach will be employed. The Research and Development Programs in support of merchant marine safety, specifically the 1972 Ports and Waterways Safety Act, are under revision at this time and the recommendations of the Board will be considered as inputs to the revision. The Coast Guard's Fire Test Facility at Mobile, Alabama is available to industry and the academic community and is utilized quite frequently for their research projects.

11. The recommendation that existing regulations regarding tank atmosphere testing be revised is concurred with. The revision of Subchapter "O", "Certain Bulk Dangerous Cargoes", is in its final stages and the proposed regulation should be approved and effective in the relatively near future. These proposed regulations specify that toxic and flammable gas analyzers will be required aboard certain vessels and must be maintained in a reliable condition.

12. The recommendation that regulations for cargo tank venting be amended for vessels in benzene service is included in the presently proposed new Subchapter "O", "Certain Bulk Dangerous Cargoes." The new proposed regulation requires controlled (not closed) venting systems (PV Valves) and a closed gauging system. The recommendation that consideration be given to requiring existing tank vessels in benzene service to be fitted with cargo vents as required for grade "A" liquids is not concurred with. There is nothing in the Board's report that supports the venting changes it recommends. At the time of the casualty, the tanks were being gas freed and were open. It would be inconsistent to isolate benzene from more hazardous cargoes which would be moving in tankers with less sophisticated venting equipment on the basis of speculation of the Marine Board in this case.

13. The recommendation that the Coast Guard issue a Notice to Mariners to remind seamen of the need to ground tank washing and venting equipment has been accomplished. Notices to this effect were issued in March 1972 and reminders of this most important safety consideration will be promulgated periodically in the Proceedings.

14. The recommendation that the Coast Guard expand its capability for search and rescue by providing equipment which can be expected to locate large metallic objects below the surface of the water is not concurred with. The low frequency of use for this type of equipment does not justify a large expenditure. When this equipment is needed the U. S. Navy and commercial sources are available and have been used in the past.

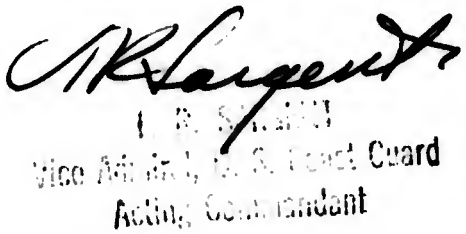
15. The recommendation that the Coast Guard accelerate research and development efforts in the EPIRB field is being acted on at this time. A Notice of Proposed Rule Making published by the Coast Guard in the Federal Register of March 5, 1973 would require certain classes of vessels to carry an emergency position indicating radio beacon (EPIRB) which, if the vessel should sink, would float free and automatically activate. There are such devices designed for coastwise vessels operating in the relatively shallow water of the continental shelf which remain tethered to the vessel, serving as a wreck marker as well as a homing beacon for search and rescue forces. In addition, two very active Coast Guard Research and Development efforts in this area are underway. These are the Distress Alerting and Locating Systems (DALS) and the Global Rescue Alarm Network (GRAN) projects. DALS is a Coast Guard effort aimed primarily at the recreational boater within 20 miles of the coast but has the potential of being extended to worldwide coverage with satellite relays. GRAN is a Coast Guard, Tri-service, and NASA experiment to demonstrate the feasibility and potential of a worldwide system. Both DALS and GRAN will not only send out an alerting distress tone but will also relay information to determine the location of the incident.

16. The recommendation that the Coast Guard initiate a study of the effectiveness and practicality of sonar beacon devices for use in locating and marking sunken vessels will be considered. It is noted that underwater locating devices are presently fitted on chlorine barges, and hardware of that type may have an effective use on oceangoing vessels. The underwater frequencies recommended for dedication to search and rescue have been proposed and are presently under review. If adopted this proposal would set aside portions of the hydroacoustic frequency spectrum for safety uses under Coast Guard management. It would also require acoustic locating devices on undersea vehicles. To achieve sufficient range to be of practical assistance in a search, the acoustic locating device would be large, require high power, and be extremely expensive. The low cost, low power, short range device has application in certain circumstances, such as high risk or experimental vessels and for situations in which the general location of the vessel would be known. It is not anticipated at this time that these devices will be required on surface vessels.

17. The recommendation that the Coast Guard encourage union training schools and U. S. Maritime Administration Schools to include in their curriculum a course of study on chemicals being moved in bulk on our waterways is concurred with. The evidence that the crew of the FOGG were inadequately trained is not surprising. Human error statistics predominate the marine casualty files. Programs to combat and reverse this personnel error involvement have been initiated, many promising avenues have opened, much remains to be done. The Coast Guard will continue to support and encourage all of these programs.

18. The recommendation that the Coast Guard prescribe that all persons who serve aboard ship for the purpose of cleaning tanks at sea be merchant seamen with a rating of able seaman is not concurred with. Requiring that tank cleaners hold a Merchant Marine Document endorsed as tankerman or some equivalent is considered more appropriate and is under consideration.

19. The recommendation that the Coast Guard initiate a comprehensive review of the requirements for licensing and certificating of officers and men to insure that those who serve aboard chemical tankers have requisite knowledge of the cargoes carried is concurred with. A program to explore the possibilities of expanding Coast Guard examining procedures to encompass overall proficiency testing methods via simulators, audio-visual instruments and mandatory training course completion and possible legislation to allow the Coast Guard to require ongoing re-certification and knowledge demonstrations is presently being examined. In addition active consideration is being given to promulgating regulations directed at mandatory training for personnel assigned to vessels carrying hazardous cargoes.



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Vice Admiral, U. S. Coast Guard
Acting Commandant

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

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5943/4601
25 August 1972

From: Marine Board of Investigation
To: Commandant (MVI)

Subj: SS V. A. FOGG, O.N. 244971; sinking with loss of life in Gulf of Mexico on 1 February 1972

Findings of Fact

1. On 1 February 1972, about 1545 CST, while enroute from Freeport, Texas to Houston, Texas, the SS V. A. FOGG suffered multiple explosions, rapidly lost bucyancy and sank within minutes in latitude 28°35'34" North, longitude 94°48'44" West. The vessel came to rest on the bottom with its radar antenna projecting about two feet out of the water. Of the entire crew of thirty-four persons and five laborers aboard the vessel, all perished. Three bodies have been recovered; two of the bodies have been identified and one remains unidentified. The other persons are missing and presumed dead.

2. Description of vessel involved:

Name	SS V. A. FOGG (Ex SS FOUR LAKES)
Official Number:	244971
Service:	Tank Ship
Gross Tons:	12,569
Length:	552.5'
Breadth:	75.3'
Depth:	39.3'
Propulsion:	Steam Turbo-Electric
Horsepower:	6,000
Speed:	Estimated 14-15 Knots
Home Port:	Wilmington, Delaware
Owner:	Ithaca Corporation 100 W. 10th Street Wilmington, Delaware
Operator:	Texas City Tankers, Inc. P. O. Box 1271 Texas City, Texas 77590
Master:	John E. CHRISTY 11602 Kirkmeadow Drive Houston, Texas 77034

Certificate of Inspection:
Last Inspection: Biennial
Date: 28 August 1971
Port: Jacksonville, Florida
Document: Consolidated Enrollment and License
Temporary Number 75
Galveston, Texas
Issued 16 December 1971

3. Personnel:

(a) Crew - known dead:

Name: Mandell BARTON, Z-816633-D2
Able Seaman
[redacted]
NOK: [redacted]

Name: John E. CHRISTY, L # 369446.
BK-298088, Master
[redacted]

(b) Crew - Missing and presumed dead:

Name: Jose Antonio ALEMANY, Z-940885-D2,
Engineman
[redacted]

Name: Douglas M. BITTICK, L # 368405,
Z-85545, Chief Engineer
[redacted]

Name: David Harold BOLTEN, Z-615070,
Galleyman
[redacted]

Name: John T. BRADFORD, Z-250808-D1, Engineman

[redacted]

Name: Ead DAVIS, Z-1021456-D1, Crew Messman

[redacted]

Name: Vincent A. EGAN, Z-68050, Able Seaman

[redacted]

Name: Lawrence L. FORBES, Z-089-03-0086,

[redacted]

Name: Paul Malone GARNER, Z-859710, Engineman

[redacted]

Name: Roy Francis GEISER, L #400730, Z-1244476, 3rd Mate

[redacted]

Name: Paul Joseph GENNUSA, L #387524, BK-75176-C2, 2nd Mate

[redacted]

Name: Robert GRANT, Z-1186151, Wiper

[redacted]

Name: Bodvar GREGERSEN, L #336027, Z-204921, Chief Mate

[redacted]

Name: William HAHN, Z-749445-D1, 2nd Cook

[redacted]

Name: John M. HELLESFORD, Z-929358-D1, Ordinary Seaman

[redacted]

Name: Coolidge B. HOWE, Z-403007-D2,

[redacted]

Name: James L. HUGGHINS, L #365065, Z-101248D1, 3rd Assistant Engineer

[redacted]

Name: Sheridan R. KING, L #TI 19 421, Z-268304-D1, Radio Officer

[redacted]

Name: William Roy Mac DONALD, L #392441, Z-867961-D2, 3rd Mate

[redacted]

Name: Joseph MAGUIRE, Z-491449, Chief Pumpman

[redacted]

Name: Tommy Lee McGREGORY, Z-357633, Able Seaman

[redacted]

Name: Arlie MISKELL, Z-922076-D1, 2nd Pumpman

[redacted]

Name: Charles O. NEECE, Jr., Z-560642R, Able Seaman

[redacted]

Name: Everett J. PARSONS, Z-450264-D2, Steward

[redacted]

Name: Jose Antonio PIEDRA, Z-1167693, Ordinary Seaman

[redacted]

Name: Jerry L. PINYERD, L #39557, Z-1297921, 3rd Assistant Engineer

[redacted]

Name: Everett PORTER, Jr., Z-491031, Able Seaman

[redacted]

Name: Lawrence Theodore REDIESS, Z-611734-D4, Able Seaman

[redacted]

Name: Rogelio RIBOTT, Z-952672, Bedroom Utility

[redacted]

Name: Martin RODRIGUEZ, Z-688770-D1, Saloon Messman

[redacted]

Name: Marcelino SALGADO, Z-759859-D1, Chief Cook

[redacted]

Name: William SCHULTZ, L #371902, Z-618332, 2nd Assistant Engineer

[redacted]

Name: Ira Herndon STARRATT, L #408658, Z-118195-D1, First Assistant Engineer

[redacted]

(c) Laborers - Missing and presumed dead:

Name: Oscar B. GARZA

[redacted]

Name: Alfonso ORTIZ

[redacted]

Name: Oscar Pena PEREZ

[redacted]

Name: Juan T. SIERRA

[redacted]

Name: Hector ZARATE

[redacted]

4. Weather Data:

The following analysis of weather prevailing at the time, date and location of the casualty is predicated upon wind observations recorded at a Shell Oil Company's offshore platform located about twenty-five miles South, Southeast of Galveston and about twelve miles North, Northeast from the wreck of the SS V. A. FOGG, and upon various observations recorded at Galveston, Texas, by the U. S. Weather Bureau and the Federal Aviation Administration:

Wind: Gentle Northerly breeze (8 knots); diminishing
Sea Height: 1-3 feet
Air Temperature: 49°F
Water temperature: 56-61°F
Barometer: 29.86 inches; falling
Relative humidity: 83%

Small craft warnings from Brownsville to Port Arthur, Texas, were discontinued at 1245 CST on 1 February 1972. Until 1243 that afternoon light rains were picked up by Galveston radar (Weather Bureau), which has a range of 250 miles. By 1345 the radar no longer showed precipitation. The precipitation previously noted was insufficient to cause electrical disturbances.

5. History of Vessel:

a. Configuration and Arrangement:

The SS V. A. FOGG, a standard T-2 tank vessel, was built and named the SS FOUR LAKES at Mobile, Alabama, in 1944. It was acquired by Tanker "FOUR LAKES", Inc., in 1957 and operated by Texas City Tankers, Inc., and its predecessor company, Texas City Refining, Inc., for several years in Coastwise petroleum service. In 1959 it underwent extensive

modification or jumboizing by renewal of the entire cargo carrying midbody from frames 83 to 46 at Maryland Drydock Company, Baltimore, Maryland.

The new midbody was built at Orange, Texas, towed to Baltimore, Maryland and joined to parts of the original vessel. The original forebody including the forward pump room was retained as was the after end of the ship, which included the engine room, after pump room and living accommodations. The amidships house was refitted and reused. After jumboizing, the vessel was similar to its previous standard T-2 appearance; however, it was now about fifty feet longer and had twenty-seven cargo tanks instead of twenty-six. Gross tonnage increased from 10,172 to 12,569.

There were nine cargo tanks numbered 1 through 9 from forward aft, each separated by a transverse bulkhead. They were further divided by longitudinal bulkheads into port, center and starboard tanks for a total of twenty-seven individual cargo tanks. The capacity of a center tank was approximately 9900 barrels when ninety-eight percent full, and each measured about thirty-six feet long, forty feet wide and forty feet deep. The capacity of the wing tanks, port and starboard, varied from 3257 barrels to 5500 barrels. Wing tank dimensions varied due to the shape of the hull; however, a typical wing tank measured thirty-six feet long, nineteen feet wide and forty feet deep. Total cargo carrying capacity was 176,123.9 barrels.

The original pumping machinery was retained but an improvement in the vessel's pumping capacity was made by the installation of another electric driven cargo pump in the after pump room.

In 1964 the cargo tanks and structurals were ultrasonically gaged and found within acceptable tolerances in that there was less than a five percent overall reduction in thickness of material. The interior surfaces of all cargo tanks were sandblasted and coated with Dimetecote 3, an inorganic zinc silicate coating, intended to arrest further corrosion. The coating gave the interior surfaces of the tanks a hard, relatively permanent, smooth gray finish.

The SS V. A. FOGG was not fitted with any type of inerting equipment or system which could be used to introduce inert gasses into the cargo tanks. It was never the practice on board to inert tanks by any other means at any stage of gas freeing, cleaning or while loading or discharging cargo.

b. Deep Well Pumps:

In 1969 twelve inch vertical deep well pumps were installed in the number 3 and number 9 port and starboard tanks. The pumps were Byron Jackson four stage cargo and stripping pumps, type 12LS14CGH, each driven by a Coppus single stage impulse type steam turbine mounted over the pump for vertical operation. The turbines were model TFV22L turbines, rated at 160 horsepower at 1770 RPM and the pumps were rated at 2,000 gallons per minute at 1770 RPM.

Steam supply and exhaust lines were installed and fitted to the turbines. Steam was supplied from the main boiler superheated steam line at approximately 500 psig.

The pump turbines were furnished with a constant speed governor to control the range of speed under load changes. An excess speed safety trip was also provided. This device was designed to close the stop valve on the live steam line should the turbine reach a predetermined speed in excess of the normal operating speed. A manually controlled fresh water cooling system was provided for the upper and lower turbine bearings.

The turbine was mounted on the pump mounting flange or yoke which was in turn secured to the deck. The driving and driven units were connected by means of a flexible coupling.

The pumping units, supported by the mounting flange, were housed in a sump or well which extended down into the cargo tanks. The pump shaft was sealed in a conventional type seal provided with a bleed off arrangement designed to reduce pressure. The fluid bled off, which in all cases was cargo or the contents of the tank and was directed back to the pump suction. The pump was designed to automatically perform pumping and stripping. To operate satisfactorily it was necessary for the suction well or sump to be partially filled with liquid. The pump was built with a self-priming feature, but some manual manipulation of valves was required when stripping and when flow was reduced. Lubrication of the pumping unit was by the liquid being pumped. Loss of prime or suction was usually accompanied by noise readily noticeable by personnel on deck. From 1969 until the day prior to the casualty the pumps had experienced several malfunctions. The most recent major repair to a pump was on 31 January 1972. This involved installation of a new mounting flange or yoke on the number 9 port deep well pump turbine. The yoke had cracked on the previous voyage and the pump had to be secured while pumping cargo. The failure was accompanied by sparking and excessive heat of friction due to misalignment of the mov-

ing parts. Replacement of the yoke was accomplished while the vessel was at the Dow Chemical Dock at Freeport, Texas. The work was done by the shore mechanics employed by Marine Repairs, Inc. of Houston, Texas. The repair proved satisfactory as the pump was used to discharge cargo at the Phillips Petroleum facility on the following day.

Other malfunctions at other times involved replacement of pump seals, repair and adjustment of governor mechanisms and in 1970 replacement of the entire number 9 port pump assembly due to damage caused by rags lodged in the pump. On 1 February 1972 cargo operations were slowed because of a governor problem on the number 3 starboard pump.

The deep well pump installations were supplemental to the existing cargo pumps located in the pump rooms. The purpose of the deep well pumps was to increase the vessel's capability for carrying different grades of petroleum products and chemicals by providing separate and segregated means of pumping these cargoes.

In August 1971 while at a shipyard in Jacksonville, Florida, the two vertical deep well pumps on the after deck were interconnected by means of a six inch crossover or "run around line". The two deep well pumps on the foredeck were similarly connected. The after crossover was run through the cofferdam, into the pump room and connected the port and starboard deep well pumps in the number 9 tanks. The forward crossover was run through the number 1 forward bulkhead into the cofferdam on each side of the ship, into the pump room where it was joined and fitted with a Weco/Hamer Blind in this space. The addition of these lines permitted a greater degree of flexibility in that a pump on either side of the ship could be used to pump from the tanks on the other side in the event of a mechanical failure.

c. Boiler Retrofit:

The boiler controls were modified during the August 1971 shipyard period.

The new "automated" or "retrofitted" boiler burner management system was comprised of several components including new steam atomizing burners for the boilers which were added to or integrated with the existing Bailey Combustion Control Board and feed water control equipment. The existing feed water control valve and its actuating mechanisms were replaced with new equipment which was controlled and operated on a two element sensing arrangement.

The boiler burners and boiler burner fronts and

their control equipment were changed from the original standard T2-SE-A1 equipment to a two burner wider range higher capacity burner management system.

All new equipment was controlled and regulated by Todd CEA electronic consoles. The consoles were intended to monitor and control the boiler operation automatically by means of sensors, electronic and air relays, and electric and air operated circuitry. One console was placed in the boiler room adjacent to the existing Bailey Combustion Control Board and the other was installed near the main engine throttle control station. An engine room trouble alarm was incorporated in the new console. The original sound powered phone installation to the engineers' quarters was retained.

In addition to the automatic operation and control of the boilers over a wide range of engine operating conditions, the system was designed to provide alarms and automatic shutdowns in the event of unsafe conditions existing or in the event of malfunction of vital parts of the system. Low and high water alarms and indicators were installed, as were those for excess feed water pressure, low feed water pressure and low instrument air. Manual controls including manually initiated boiler furnace purge and restart were provided.

Since the vessel was built it had been customary to operate the steam turbo-electric propulsion plant with a three man watch. This watch, changed every four hours while underway, consisted of a licensed engineer who was in charge of and supervised other personnel on the watch. His normal duties included rounds of the operating machinery, minor maintenance and while maneuvering, duty as throttle man. The unlicensed oiler assigned, recorded or logged data, made routine rounds of machinery and assisted the engineer as directed. The fireman/watertender supervised the boilers, tended water if necessary and changed burners as required.

One purpose of the automation or "retrofit" was to provide unattended automatic boiler operation looking toward a reduction in manning in the main machinery space, by the substitution of equipment capable of performing the functions heretofore performed by a fireman/watertender.

In accord with the recent trends in the shipping industry, current Coast Guard policy permits vessels mechanically propelled to be altered or modified by the addition of more modern and automatic equipment so as to qualify the vessel for reduced manning.

The underway tests as witnessed by a Coast Guard marine inspector, American Bureau of Shipping representative

and a company representative, were accepted as evidence that the new equipment was capable of safely performing the functions of a fireman/watertender, and that the installation met the standards prescribed by existing regulations. Accordingly, the requirement for three fireman/watertenders was removed from the Certificate of Inspection issued by the Officer in Charge, Marine Inspection at Jacksonville, Florida. The engine room underway and in port watches were now manned by a licensed engineer and one engineman in lieu of the engineer, oiler and fireman/watertender formerly required. Further personnel reduction was accomplished by the elimination of one steward/utilityman and one wiper. The latter two ratings were not required to be carried by the Certificate of Inspection, but were permitted to be carried as persons in the crew, not connected with the navigation of the vessel.

Upon departure from the shipyard in August 1971 the vessel resumed its normal schedule which included calls at Gulf Coast, East Coast, Puerto Rican and return to Gulf Coast ports. Malfunctions of the new boiler equipment were experienced on several successive voyages. Most of these were failures of minor components which required underway adjustment. There were other malfunctions which resulted in emissions of large amounts of black smoke, flames and sparks from the stack and in several instances loss of power on board.

Another effect of the retrofit was a reduction in the boilers' response to rapid throttle changes when maneuvering. After the retrofit the engineers were required to handle the engine throttle controls more slowly, with deliberate care in order to avoid a loss of power by inadvertently activating the newly installed safeguards. This condition was somewhat alleviated by training the engineers to respond with throttle changes more slowly. The danger of blacking out the plant was a real possibility should the engineer attempt to handle the throttles as before.

The new installation did not include a call bell system in each engineer's room although audible alarms were fitted to sound in the machinery spaces.

After the new equipment was installed most functions of the boiler operations were automatic and unattended; however, the blowing of tubes was still performed manually with the original unmodified soot blowers. This necessary process was done twice daily at sea. Customarily it was performed on the four to eight AM/PM watches by the second assistant engineer and a wiper or another unlicensed man. Its purpose was to remove soot and fly ash from the surfaces of the boiler generating and superheater tubes, thereby aiding in heat transfer

and efficiency of the boilers. Because of the vessel's proximity to populated areas or refineries; the hazards when loading or discharging; and local prohibitions against pollution of air by stack emissions, soot blowing was not usually performed in port.

Divers' photographs and comments on video tape taken after the casualty reveal no unusual condition in the engine room or the boiler room such as fire damage to boiler fronts, boiler casings or other adjacent necessary equipments.

d. Cargo Tank Hatches:

Each cargo tank was fitted with one circular hatch trunk with a coaming approximately thirty-six inches high and sixty inches in diameter. Each trunk was fitted with a hatch cover or tank top fabricated of aluminum. When closed, this hatch cover fitted tightly over the trunk and was secured in place by swing bolts and wing nuts on the coaming which engaged clips made fast to the covers. Installed in each cover were standard circular ullage openings, each fitted with a portable screen and a cover with a strongback-locking pin securing device. Screens used on the SS V. A. FOGG were of fine mesh stainless steel wire screen, secured inside an aluminum ring. The hatch covers were fitted with a davit type strongback and screw lifting device which permitted the cover to be lifted by a handwheel and swung clear of the opening. This device permitted the cover to be raised or secured quickly by one or two men. Provision was made to secure the cover and davit in the open position by means of a locking pin.

e. Cargo Tank Venting:

Each cargo tank was constructed with an individual four inch vent line installed in the tank top hatch trunk. The vent line terminated with a flange at the level of the edge of the hatch trunk. Secured to the flange was a Coast Guard approved pressure-vacuum relief valve, fitted with louvers, flame screens and an adjusting handwheel.

f. Cargo Segregation:

In 1969 Weco/Hamer (three bolt type) blind valves were installed in the ten inch cargo piping systems in the number 4 port and starboard tanks; one at the forward end and one at the after end of each tank. Those in the numbers 5 and 6 wing tanks were installed at the after bulkheads. These valves further facilitated cargo segregation in the port and starboard tanks. Circumstances connected with washing tanks or cargo segregation sometimes arose which required men to enter gassy tanks to open or close one or more of these valves.

The Weco/Hamer blind valves installed in the suction lines were of the weld neck type. The body of the valves was triangular in shape, fitted with spool shaped nuts and bolts at the three apexes of the triangle. The spool nuts were designed to spread the flanges of the valve when turned with a bar. The position of the spectacle plate mounted on one of the bolts could then be reversed by lifting and revolving it in either direction. The spectacle plate was constructed with one blind side and one open spectacle side which enabled the valve to be set in either open or blind position. Leverage for opening or closing the bolts was afforded by use of a long portable operating bar which, when in use, was inserted in the bolt heads. Design characteristics intended that the valve be opened or closed in a short time by one man using the operating bar. In practice, on the SS V. A. FOGG, more than one man was employed to open or close a valve. Often three men were required to change the position of a blind in the tanks. On occasion, use of the operating bar was insufficient to slack the bolts. In these cases a hammer or other tool was used on the bar; the task requiring from thirty-five minutes to several hours.

The vessel was also fitted with sluice valves on longitudinal bulkheads throughout the cargo tanks. Those fitted between the numbers 1-2-3-7-8 and 9 centers and wing tanks were blanked off. Those between the port and starboard tanks and the numbers 4-5 and 6 centers were not blanked but were fitted with reach rods and hand wheels, operable from the deck.

g. Biennial Inspection/Dry Dock Examination:

The SS V. A. FOGG was last drydocked in August 1971 at Jacksonville, Florida. At that time it was gas freed and underwent dry dock examination and biennial Coast Guard inspection. Items of repair in excess of two hundred and twenty-eight were accomplished. Most of the items were minor and involved routine maintenance. There were other items which included hull repair, overhaul and inspection of machinery and equipment attendant to the biennial inspection, installation of additional "automated" equipment to the boiler combustion control and burner management system, and alterations of the cargo piping system for the deep well pumps previously described. Hull repair included renewal of hull plate C5 in way of the port forward cofferdam and deep tank. A satisfactory hose test of this plate renewal was accomplished on 27 August 1971. The stern bearing was rewooded and a new tailshaft and propeller were installed.

During the shipyard period, the vessel's underwater body and external hull fittings were examined and found satisfactory. All cargo tanks, deep tanks and cofferdams were entered and found to be structurally sound and in good condition. Minor defects noted by the inspectors were completed prior to sailing. After satisfactory completion of repairs and underway tests of the new boiler combustion control equipment, the vessel underwent a fire and boat drill under the supervision of a marine inspector. A new Coast Guard Certificate of Inspection was issued on 28 August 1971 permitting the carriage of grade "B" and lower flammable and combustible liquids. The Certificate of Inspection and a newly issued Certificate of License and Enrollment reflected the vessel's change of name on 11 August 1971 from SS FOUR LAKES to SS V. A. FOGG. An American Bureau of Shipping surveyor attended the vessel during this period and it was retained in class. The vessel held a valid Safety Equipment Certificate issued by the Coast Guard and a valid Load Line Certificate issued by the American Bureau of Shipping.

American Bureau of Shipping representatives and Coast Guard inspectors viewed the cargo handling system while the vessel was in the shipyard during August 1971. The ship was then in a gas free condition with no cargo on board. Cargo handling by use of this ship's cargo system was not observed by these inspectors.

The Consolidated Enrollment and License was changed on 16 December 1971 to reflect a change of corporate ownership from Tanker "FOUR LAKES", Inc., to "Ithaca Corporation" of Wilmington, Delaware.

6. Vessel Operations:

a. Background:

Texas City Tankers, Inc., and its predecessor company, Texas City Refinery, Inc., had operated the SS V. A. FOGG under a bareboat charter from its owner, Tanker "FOUR LAKES", Inc., since 1956. Two other vessels, the SS WILLIAM J. FIELDS and the SS WILLIAM T. STEEL, regularly operated by this same company, are jumboized T-2 type tank vessels. The SS WILLIAM J. FIELDS and SS WILLIAM T. STEEL are considered standard four grade tankers; however, the SS V. A. FOGG had greater cargo versatility and cargo segregation capability, due to the additional pumping and piping arrangements previously discussed. The SS V. A. FOGG had been employed in coastwise service since 1956. For the past four or five years it had been engaged in moving partial cargoes of methanol from Houston and petroleum products from Texas

City to the East Coast. In the latter part of 1970 the vessel was employed to move petrochemicals including benzene from Puerto Rico to the Gulf Coast. A routine, triangular voyage between the Gulf, East Coast, Puerto Rico and then back to the Gulf was thus established. The necessity for frequent tank cleaning due to changing of cargoes was a part of the vessel's routine operations.

Tank cleaning during return voyages from East Coast ports was usually carried out by crewmembers in the deck department. The usual three day passage from the East Coast to Puerto Rico gave ample time to effect tank cleaning in preparation for loading benzene, xylene and occasionally other products in Puerto Rico.

When scheduled outbound from Gulf ports with cargo which required clean tanks and the removal of residual previous cargo, the time allotted for tank cleaning was reduced. Such was the case on this voyage, when the vessel was scheduled to load methanol at Houston, Texas, on 2 February after discharge of benzene at Freeport, Texas, on 1 February. To save time, and to supplement the deck department in order to expedite tank cleaning, shore laborers were often employed. The laborers were not considered as passengers or members of the crew, but were "persons in addition to the crew". As such, these laborers did not hold Merchant Mariner's Documents and did not appear on the "Master's Report of Seaman Shipped or Discharged", Form CG-735T. The Certificate of Inspection on the SS V. A. FOGG permitted the carriage of seven persons in addition to the crew.

b. Company Administration:

The operating company, Texas City Tankers Inc., was administered by Mr. William H. JOHNSON, the marine manager, whose offices were in Texas City, Texas.

Matters of an engineering nature requiring shoreside support routinely were handled by the firm of Charles MALLYNN and Son, Houston, Texas, independent marine surveyors. This firm provided support and inspection services for repairs, shipyard overhauls and routine maintenance on a retainer basis for the operation of the SS V. A. FOGG and the two other vessels operated by Texas City Tankers, Inc. This was a long standing relationship that had existed for about fifteen years. The installation of the new midbody, the application of the tank coating, and recent retrofit of the boilers on the SS V. A. FOGG were all accomplished under the supervision of this firm.

c. Officers and Crew:

The crew of the SS V. A. FOGG was employed through labor contracts with maritime unions. Labor contracts existed with the International Organization Masters, Mates, and Pilots, The National Marine Engineers' Beneficial Association, The Radio Officer's Union and the National Maritime Union. Those persons serving as Master, Chief Mate, Chief Engineer and First Assistant Engineer were hired directly by the company and were members of their respective unions. The remainder of the officers and crew were obtained from the union hiring halls.

Employment records reflected an unusually stable crew. After vacations or other off periods officers and crewmembers often would return to the vessel. A large percentage of the officers and crew had served aboard the vessel for several years. Relief personnel for regular crewmembers on vacation often would be personnel who had served aboard the SS WILLIAM J. FIELDS or the SS WILLIAM T. STEEL, the other two vessels in the company fleet.

Files reflecting R. S. 4450 action (Suspension and Revocation Proceedings) on all officers and crew who had served on the vessel within the past eight months were reviewed at Coast Guard Headquarters. Disciplinary records for these seamen reflected minimal offenses for which R. S. 4450 action had been taken. The conduct record of officers and crew who had served on board the SS V. A. FOGG was evaluated as "better than average".

Promotion to the position of Master was usually based upon seniority within the company fleet. Upon retirement of a Master, the position would usually be filled by the next senior man holding a master's license. The regular Master of the SS V. A. FOGG, Captain Reuben H. McLAURIN, had been employed by the company since 1960 and as permanent Master since 1968. Captain McLAURIN was on vacation at the time of the casualty, and the regular Chief Mate, John E. CHRISTY, was serving as Master. Captain CHRISTY had been employed in the company for over ten years, starting as Third Mate. He enjoyed a reputation as a very prudent man and had previously served as Relief Master aboard this vessel.

d. Safety Program:

Safety meetings or organized training periods with the exception of required fire and boat drills, were not incorporated into the vessel's routine. There was on board in the Master's office the manual, "Accident Prevention for Tank Ships," a United States P & I Agency Inc., publication which

prescribes guidelines and procedures for use by officers and crews on tankships. The publication recommends that a ship's safety committee be organized with officer participation in it, that safety conferences be held, that there be effective leadership and supervision. It also delineates safety goals and the methods to be used in their attainment.

The "Operating Instructions" prepared by Texas City Tankers Corporation contain no information on the subject of a ship's safety program; however, they do contain an instruction promulgated by the Military Sealift Command, to be followed for the safe handling of U. S. Government cargoes, specifically jet fuels and kerosine. Although the vessel is routinely engaged in the benzene trade, there were no company instructions relative to specific practices to be followed in gas freeing and cleaning cargo tanks which have carried benzene. Of the other publications reported to have been carried on board, none contained detailed written instructions oriented to tank cleaning and gas freeing or to the specific conditions which existed on the SS V. A. FOGG. With the exception of the warning signs, i.e., no smoking, no visitors, no open lights which are prescribed by regulations, there were no restrictions on the carriage of matches or cigarette lighters; however, smoking areas were designated and marked on the weather deck.

Available for guidance on board the SS V. A. FOGG in safety matters were "Tank Vessel Regulations", CG 123, "Laws Governing Marine Inspection", CG 227, and the "U. S. Coast Guard Chemical Data Guide for Bulk Shipment by Water", CG 388. The latter publication contains information on benzene, its characteristics and hazards.

The use of a combustible gas indicator prior to tank entry was not a routine practice. Toxic property analyzers or oxygen analyzers were not used or carried on board. It was commonplace to use sense of smell, the absence of dizziness, headache and drowsiness as major indicators to determine whether it was safe to enter or remain in a tank.

e. Emergency Drills:

Coast Guard regulations for tank vessels stipulate that fire and lifeboat drills must be held at least once in every week. The drills are to be accomplished precisely as though an emergency did in fact exist. To achieve such degree of simulated emergency, the Master, or the Mate or officer next in command, must call all hands to quarters and (weather permitting) exercise them in the unlashing and swinging out of the lifeboats, the closing of all hand or power operated watertight doors which are in use at sea, the

closing of all fire doors and screens, the use of fire pumps, and all other apparatus for the safety of life on board of such vessels with special regard for the drill of the crew in the method of adjusting life preservers; to see that all equipments required by law are in proper working order for immediate use; and to see that the lifeboat equipment is examined at least monthly to insure that it is complete.

During lifeboat drill the lifeboat covers and strongbacks shall be removed, and boat plugs or caps put in place. Boat ladders shall be secured in position for use, and painters carried forward and tended so as to provide a good lead and slack to hold the boat in position under the davits when in the water. Lifeboats, weather permitting, shall be unlashed and swung out over the side during each drill. Different groups of lifeboats shall be used in turn at successive boat drills and, if practicable and reasonable, every lifeboat shall be lowered at least once every three months.

Fire and boat drills must be properly conducted to see that equipment is in complete working order, ready for immediate use, and that all hands are trained, instructed and ready to put the equipment to proper use should an emergency such as fire or need to abandon ship arise. Any neglect or omission on the part of any officer in command of a tank vessel to strictly enforce Coast Guard regulations speaking to the holding of fire and boat drills shall be deemed cause for proceedings under the provisions of R. S. 4450, as amended (46 USC 239), looking to a suspension or revocation of the license of such officer.

Fire and lifeboat drills were usually conducted weekly aboard the SS V. A. FOGG when the vessel was at sea. All hands attending the drills were required to wear life preservers. Hoses (usually two) were stretched out and water pressure applied during fire drills which lasted about twenty minutes. The crew was mustered at quarters for lifeboat drills, but the boat covers and strongbacks were not removed. The boat plugs or caps were not put in place. Sea painters were not lead out or attended. Irrespective of weather prevailing at the time, the lifeboats would not be unlashed and swung out; customary procedure was to merely release the boat falls and crank out the davits. Boats were not lowered to the water every three months.

During Board inquiry into the manner in which drills were conducted aboard the SS V. A. FOGG, one crewmember of seven months revealed that he had never performed and did not understand his job of putting in the boat plug, and that during his ten years at sea he had never been in a lifeboat.

7. Last Cargo Carried:

The last cargo lifted by the SS V. A. FOGG was loaded in Puerto Rico for delivery to Texas ports. Benzene in the amount of 122,922.34 barrels (16,967.89 long tons) was loaded into numbers 1, 2, 3, 5, 6, and 7 center tanks, and into numbers 1, 2, 3, 4, 6, 7, 8, and 9 port and starboard tanks. Xylene in the amount of 19,009.99 barrels (2,578.11 long tons) was loaded into numbers 8 and 9 center tanks. Number 2 center tank and number 6 port and starboard tanks were slack. No cargo was loaded into number 4 center or into number 5 port or starboard tanks. Some benzene cargo, however, did leak into number 5 starboard as evidenced by an innage of 3 1/4 inches found in that tank after arrival Freeport, Texas. Further details on amounts and distribution of cargo loaded in Puerto Rico are given by the following tabulation:

PORT	CARGO	CARGO TANKS	DESTINATION	BARRELS @ 60°F	LONG TONS
Las Mareas 23-24 Jan 1972	Benzene	1,2,3,4, 7,8,9-P&S (5 P&S empty)	Freeport Phillips Petroleum Co.	65,056.76	8,980.27
Guayanilla 24-25 Jan 1972	Benzene	1,2,3,5, 6,7 C 6 P&S (4C empty)	Freeport Dow Chemical Co. (for account Mobil Chemical Company)	40,000.00	5,521.50
	Benzene	1,2,3,5, 6,7 C 6 P&S (4C empty)	Freeport Dow Chemical Co.	17,865.58	2,466.12
	Xylene	8,9-C	Houston Tauber Oil Co.	19,009.99	2,578.11
				141,932.33	19,546.00

Analysis of the benzene cargo delivered by the SS V. A. FOGG at the Phillips Petroleum Company terminal, Freeport, Texas, on 1 February 1972 was as follows:

	SHIP COMPOSITE
Gravity, Specific @ 15.56/15.56°C	0.8840
Color, ASTM D-853	PASSES
Color, Acid Wash	0+

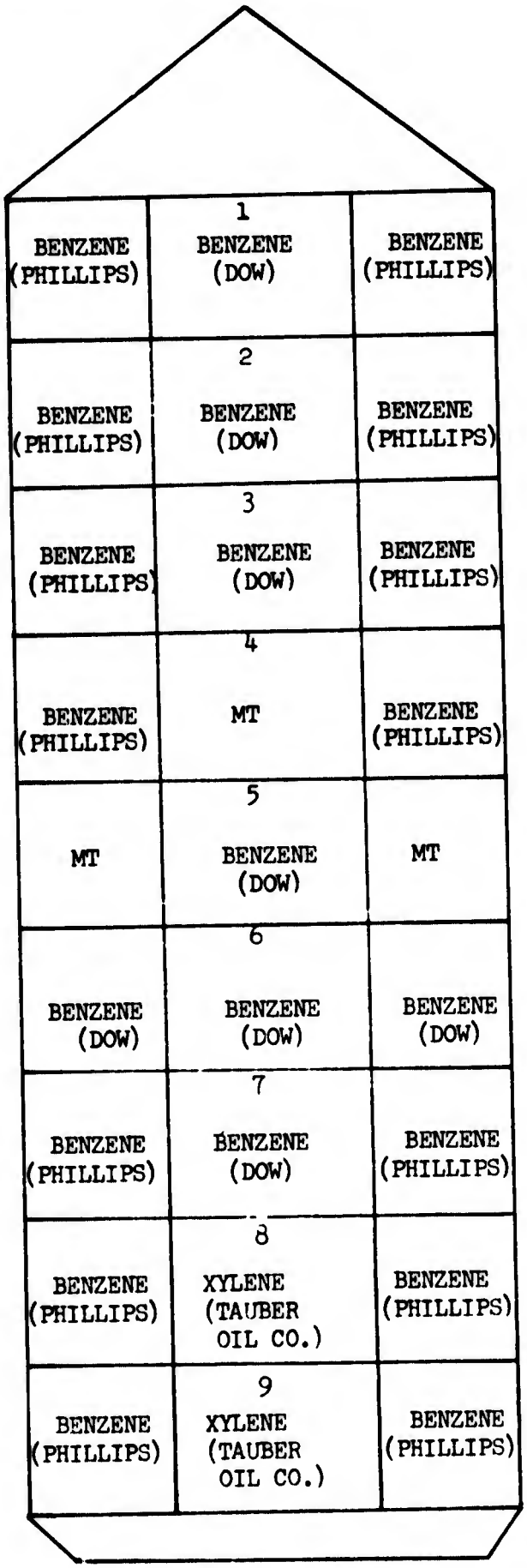
	SHIP COMPOSITE 1A
Corrosion, Copper Strip, ASTM D-849	Negative
Sulphur compounds, H_2S & SO_2	5.49
Solidifying Point, ^oC	Nil
Acidity	Less than 1
Sulphur, Thiophene, ppm	Less than 1
Total Sulphur, ppm	
Distillation, ^oC	
Initial Boiling Point, ^oC	79.9
Dry Point, ^oC	80.4
Range	0.5

Analysis of the benzene cargo as loaded in Las Mareas, Puerto Rico, was in agreement with the above.

Analysis of the xylene cargo loaded aboard the SS V. A. FOGG on 25 January 1972 at Guayanilla, Puerto Rico, was as follows:

Acid wash color	0
Ethylbenzene, %	20.4
Paraxylene, %	21.6
Metaxylene, %	55.0
Orthoxylene, %	2.9
Benzene	Nil
Toluene	Trace
Non-aromatics	0.1
Specific gravity	0.8685

CARGO PLAN ARRIVAL FREEPORT, TEXAS ON 30 JANUARY 1972



8. Freeport:

On the voyage from Puerto Rico to Freeport, Texas, a breakdown of the main propulsion plant occurred, which caused the vessel to stop and drift for approximately thirty-five minutes. This incident occurred shortly after leaving Puerto Rico and the vessel remained blacked out with loss of electric power during this period. The cause of the power plant failure or nature of corrective repairs could not be ascertained by the Board.

After the vessel's arrival at Freeport on 30 January it moored at the Dow Chemical Company terminal, at 1500. Mr. Walter O. BROWN, a petroleum inspector associated with John DAHL & Company performed cargo inspection services prior to unloading. The shore tank receiving benzene was sounded, shipboard ullages, cargo temperatures and cargo samples were taken for laboratory analysis in the routine manner. The cargo was found acceptable and discharge was commenced at 1820 using the numbers 3 and 4 main cargo pumps in the after pump room. While cargo was being discharged the port deep well pump in number 9 cargo tank, which was inoperative upon arrival, was repaired as previously described in paragraph 5b. The discharge operation continued throughout the night without incident under the supervision of Mr. Frank Frederick MANGUS, a relief night mate. Completion of discharge at Dow Chemical Company was at 1400 the following day, 31 January.

Inspection of cargo for the subsequent unloading at the Phillips Petroleum Company terminal was commenced prior to the vessel's departure from Dow. Mr. Spencer K. PARKER, a petroleum inspector employed by Charles MARTIN and Company, boarded the vessel about 0930 and obtained samples of the cargo to be discharged at Phillips. These samples were sent to the Phillips' laboratory for analysis and found acceptable.

The vessel shifted berths from Dow to the Phillips terminal arriving there at 1630. Shortly thereafter, Mr. PARKER reboarded the vessel and checked ullages and cargo temperatures prior to unloading. Unloading was commenced at 1800 and continued throughout the night, again under the supervision of Mr. MANGUS, the night mate. The number 9 port deep well pump which was repaired the previous day was used during the discharge operation and performed satisfactorily. About 0430 the starboard forward deep well pump stopped due to a speed control governor malfunction which resulted in a reduced pumping rate. This event delayed the unloading and the scheduled sailing from Freeport from 0800 to 1240 on 1 February.

Cargo tanks numbers 2 and 4 centers were ballasted to within one foot of the deck, while discharging cargo at the Phillips terminal in accordance with the Master's instructions. This was done by Mr. MANGUS, in preparation for the intended voyage to Houston.

The main plant operated without incident during the vessel's stay at Freeport. Both boilers remained on the line on automatic and vacuum was maintained on the main condenser. The main motor was turning slowly as was the practice when the vessel was scheduled for a short stay in port. No engine room repairs of any significance were reported, and the night relief engineer, while the vessel was at the Dow terminal, described the plant as operating "perfect".

Some crewmembers were changed at Freeport due to rotation for vacation. However, no officers were changed. The regular pumpman did return after his vacation. The boatswain, Mr. John CALDEIRA, Jr., failed to join upon sailing and was authorized to rejoin the vessel at Houston.

9. Departure Freeport:

a. Dock to Sea:

On 1 February at 1240 the SS V. A. FOGG departed the Phillips Petroleum plant at Freeport and proceeded to sea. Estimated time of arrival at the Galveston Sea Buoy was 0200 on 2 February. Thirty-four crewmembers, the five shore laborers furnished by Marine Maintenance Company of Houston and the pilot were aboard. Departure enroute the Freeport Sea Buoy was without incident. The tug W. A. WANSLEY attended the vessel and departed about 1305 at the intersection of the Intracoastal Waterway and the channel to sea. The pilot departed at 1315, fifteen minutes before the vessel arrived at the sea buoy. He estimated that there was a two or three knot set from the Northeast along the coast and that the visibility was three miles. Prior to his departure the pilot observed that several of the crewmembers and the five laborers were on the foredeck and that Butterworth openings and tank tops had not been opened.

b. Fresh Water and Fuel:

The Board did not have available for perusal any record which would have revealed the exact amount of fuel oil and fresh water aboard the SS V. A. FOGG when she sailed 1 February from Freeport, Texas, to clean tanks at sea. Deck and engine room logbooks in use on the day of the casualty are believed to have been lost and never recovered

from the sunken vessel. Knowledge of the actual amount of fresh water, or a close estimate thereof, would be of assistance in evaluating the extent and efficiency of tank cleaning operations to have been accomplished on the day the SS V. A. FOGG was lost. Also, an accurate determination of hogging and sagging numerals would be facilitated by knowledge of actual fuel and water quantities.

Close estimates of fuel and water aboard upon sailing Freeport can be made using the following known facts as a basis for calculations:

	Date	Bbls Fuel	Tons Water	Draft Forward	Draft Aft	Mean Draft
Departure Perth Amboy, New Jersey	1-18-72	4805	200			
Arrival Las Mareas, Puerto Rico	1-24-72	3320	135			
Departure Guayanilla, Puerto Rico	1-25-72	3090	160	27'10"	33'02"	30'06"
Arrival Freeport, Texas	1-30-72			28'00"	32'02"	30'01"
Departure Freeport, Texas	2- 1-72			8'05"	21'09"	15'01"

Fuel Oil Estimation:

The Master stated to a company representative that fuel oil sailing Freeport would be approximately 1000 barrels. This figure can be checked in the following manner. Fuel oil consumed between Perth Amboy and Puerto Rico was 1485 barrels, and distance traveled was 1492 miles. Fuel oil consumption at sea therefore is very close to one barrel per mile. In steaming an estimated distance of 1809 miles from Guayanilla, fuel on board arriving Freeport would have been approximately 1289 barrels. Consumption while in port, figured on the basis of 150 barrels per day, would have been approximately 284 barrels, leaving a balance of approximately 1005 barrels upon departing Freeport.

Fresh Water Estimation:

The Board heard various opinions concerning the amount of fresh water aboard the SS V. A. FOGG upon sailing Freeport. A total of 170 tons was projected as a reasonable quantity in

line with amounts carried on previous voyages.

A close estimate of the total tons of fresh water aboard the SS V. A. FOGG sailing Freeport, Texas, can be obtained by comparison of displacement tonnage based on sailing draft, and displacement tonnage, less water, obtained by calculation as follows:

Displacement corresponding to mean sailing draft: 12,320 tons

Calculated Displacement			
Cargo	2,578 tons		
Ballast	3,110		
Fuel Oil	151		
Water	?		
Lightship + crew and stores	6,332		
Displacement, (less water)	12,171 tons	12,171	
Water		149	tons

The above calculation was predicated on a zero fresh water allowance. Any allowance for fresh water would serve to reduce the value of 12,320 tons and thereby further reduce the calculated value of 149 tons of fresh water. Considering that the vessel had a tons per inch immersion factor of 74, an inaccuracy in the reading of the sailing draft would also affect the preciseness of the calculation.

The accuracy of the above type of calculation can be illustrated by similar comparison of displacement tonnages upon sailing Puerto Rico, at which time the record shows known quantities of cargo, fuel oil, and fresh water.

	Tons
Lightship + crew and stores	6,332
Cargo	19,546
Fuel	450
Water	160
Total displacement	26,488

Displacement corresponding to mean sailing Draft of 30'06" 26,450

Here again zero fresh water allowance was assumed.

c. Hogging and Sagging Numerals.

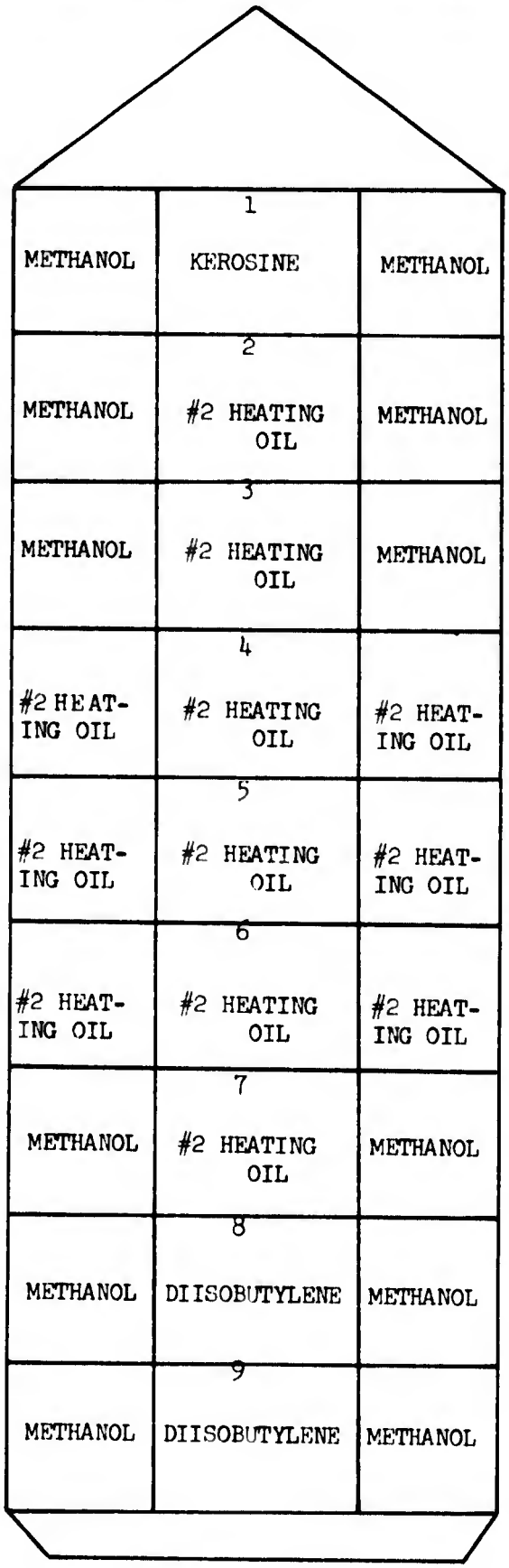
Captain CHRISTY, Master of the SS V. A. FOGG, was known to have made stress calculations for each loading of his vessel and would not have proceeded to sea with a stress numeral exceeding 100. Prior to sailing Freeport on 1 February he mentioned to a company representative that the

vessel, with ballast, would have a hogging stress numeral of 99.

The SS V. A. FOGG proceeded to sea on 1 February with center tanks 2 and 4 ballasted. Center tanks 8 and 9 contained xylene cargo. Fuel oil in the amount of approximately 1000 barrels of Bunker C was aboard. The exact amount of water is not known. However, computation as made previously in paragraph 8b shows a total of approximately 149 tons of water. Review of previous voyage reports showed 218 tons as the maximum amount of water aboard when sailing on voyages upon which tank cleaning would be conducted. A value of 170 tons is commensurate with amounts carried on previous voyages. That value of 170 tons, when used in calculation of stress, results in a hogging numeral of 96.33, and a sagging numeral of 25.88.

CARGO LOADING PLAN ANTICIPATED FOR HOUSTON - TEXAS CITY

TEXAS ON OR ABOUT 2 FEBRUARY 1972



10. Preparation For Tank Washing, Gas Freeing, and Drying:

Cargo anticipated to be loaded for the next voyage was methanol, diisobutylene, kerosine and number 2 heating oil. These products, especially benzene, were routinely carried. In the preceding two years the vessel had completed thirteen trips carrying various amounts of benzene, which upon discharging, made it necessary to wash, gas free, clean and dry tanks before the next cargo of methanol could be carried.

The development of the tank washing, gas freeing and drying procedures used on the SS V. A. FOGG reflect both the characteristics of the product just unloaded and the characteristics of the product next to be loaded in any given tank. In the present trade the old product was benzene and the new product was methanol. Those tanks into which methanol was to be loaded needed exceptional care in removal of all traces of water and benzene before loading methanol. The loading of pure, high value, methanol into a tank not free of water-benzene slops could result in a contaminated and consequently lower value methanol product. Cargo tanks which had carried benzene, and which were scheduled to carry kerosine, or heating oil, would require water washing to remove residual benzene cargo. Fresh or salt water could be used in this case, and there would be no need to remove residual water from the tanks prior to loading the kerosine or heating oil.

The SS V. A. FOGG arrived at Freeport with number 4 center tank empty. The vessel left Freeport and proceeded to sea with center tanks 2 and 4 ballasted. Past practice on the SS V. A. FOGG indicates the following ballasting/deballasting sequence as probable after departing the sea buoy:

(1) Tank 2 center would be pressed up to overflow at the tank hatch, thereby dumping on deck most of any benzene residue floating on top of the ballast.

(2) The ballast in number 2 center tank would be discharged and the tank washed in preparation for cargo of heating oil. Depending upon weather conditions and the need for ballast proceeding up the Houston Ship Channel, additional ballast could be loaded in one or more center tanks, such as 1, 3 and 5, after Butterworthing to remove benzene.

(3) Tank number 4 center was empty on the last voyage from Puerto Rico. Ballast loaded at Freeport was clean and the tank would not have to be cleaned of benzene prior to loading methanol.

As indicated previously it was routine for the operators of the vessel to provide for extra men to assist with the tank washing, gas freeing and drying of the cargo tanks in preparation for tne next cargo. The extra men or laborers were contracted for by verbal agreement between the management of the company and the Marine Maintenance Company of 7633 Navigation Boulevard, Houston, Texas. Management on the part of the vessel's operators was represented by Mr. Charles MALLYNN, Jr., the independent marine surveyor. It was a practice for Mr. MALLYNN to contact Mr. Walter D. ADDISON or another of the supervisory personnel at Marine Maintenance Company, to hire a specific number of laborers to board the ship at its port of departure, which was frequently Freeport, Texas.

The men were expected to bring necessary gear and equipment in order to clean and wipe down cargo tanks. They were to remain on board at work while the vessel was at sea between Freeport, and Houston, Texas. The Marine Maintenance Company was familiar with this type of work request, having provided laborers for many similar trips over the preceding two years. Because of the vessel's service, the methods employed and the equipment used were invariably the same and the work also involved the same cargo tanks.

On 1 February, shortly before the vessel's departure from the Phillips Petroleum Company dock the five tank cleaning laborers boarded the ship. These were: Hector ZARATE, Labor Foreman, Juan SIERRA, Oscar GARZA, Oscar PEREZ, and Alfonso ORTIZ. Equipment provided by Marine Maintenance Company was brought on board and stowed in the space below the amidships house until ready for use. The men then stood by waiting orders of the Chief Mate. Of the five men provided by Marine Maintenance Company for work on the SS V. A. FOGG, two were experienced men, regularly employed by Marine Maintenance Company. The other three, although not permanent employees, were also experienced in this type of work. These men were hired on a job to job basis, and paid by the hour. None of these men possessed US Merchant Mariner's Documents. All five of the men were Latin-Americans and four of them spoke and understood some English. The foreman was bi-lingual; whereas, the majority of the men were more proficient in Spanish. It was one of the duties of the foreman to translate the orders of the Chief Mate to the men and to see that they were carried out. It was also his duty to arrange for the equipment to be assembled at the Houston warehouse and to be brought on board.

This equipment brought on board on 1 February at Freeport was the same as that provided for a routine benzene tank cleaning job. The equipment consisted of "red devil" pumps

(usually two), with hoses and fittings, rubber buckets, aluminum scoops, cotton rags, two air hoods and flashlights. The flashlights carried by each man were approved types with plastic cases. The buckets, made of rubber composition, were common to tankships and are accepted as safe for use on tankships by the industry. The wiping rags, purchased from a wholesaler of such supplies at Houston, were brought on board in bales of approximately one hundred pounds each. The rags were of various colors and consisted mainly of old clothing. Each bale was secured and bound with wire straps.

It was the practice on board the SS V. A. FOGG to prepare for the washing and gas freeing process as soon as the pilot disembarked at the sea buoy. The men used for this task were the off-watch seamen and those seamen on watch not necessary for the navigation of the vessel. Occasionally, the laborers assisted with this work.

When clear of the sea buoy the work was commenced under the direction of the Chief Mate. Some of the men began to break out necessary ship's equipment from the storage space under the amidships house. Other men began removing the nuts from the Butterworth covers and opening all tank top hatch covers. Each cargo tank was fitted with two fifteen inch tank washing openings on the main deck called Butterworth Openings. Each of these openings was fitted with a cover of non-ferrous metal secured to the deck plating by ten non-ferrous studs and nuts.

To open the hatch covers required slacking the wing nuts on the dog bolts around the trunk, flipping them clear and raising the cover by means of the strongback and a wheel operated screw lifting device fitted to each cover. The covers were made of aluminum and all bolts and fittings directly attached were of brass or bronze. After the cover was lifted free of the trunk, it was swung clear of the opening and could be held in this position by means of a toggle pin.

The equipment to be used was assembled near the first tank to be washed and shortly thereafter tank washing was begun. The type of equipment to be used depended upon several factors which included the previous cargo carried in the tanks; the anticipated cargo to be carried and the degree of cleanliness or dryness to be achieved.

11. Tank Washing, Gas Freeing and Drying:

The usual sequence for washing, gas freeing and drying a tank which had previously carried benzene was as follows:

(1) Washing with spray nozzle device, while discharging slops with deep well pumps; thirty to forty-five minutes. (2) Ventilation with Coppus Blowers; thirty minutes to one hour. (3) Testing of atmosphere; by sense of smell and occasionally by meter. (4) Removal of residual wash water and residue not removed during washing. (5) Wiping with rags. (6) Ventilation with Coppus Blowers to further dry the tanks.

(a) Washing With Spray Nozzle Device:

Because benzene is a clear liquid, which upon evaporation leaves no residue, it had been the practice on board the SS V. A. FOGG to bottom wash benzene tanks manually, using fresh water applied by a fabricated spray nozzle device attached to a rubber water hose. This device, or spray nozzle, was preferred to the more heavy tank washing machines because of the ease of handling. It was also thought to be quicker, used less water and was believed to be well suited for this particular situation inasmuch as the interior surfaces of the cargo tanks were coated with an inert zinc silicate coating, were relatively smooth, and light product residues were easily washed down.

The sequence of the operation varied to some degree from voyage to voyage because of cargo considerations and with changes in the crew. Times allowed for each part of the evolution also varied depending upon the judgment of the person in charge. The operation usually commenced at the forward tanks on either side of the vessel, then proceeded aft. Tank washing and stripping would be facilitated by the drag of the vessel. A sequential order of 1, 2, 4, and then number 3 wing tank was followed in order to permit entry of personnel into number 4 wing tank to close the Weco/Hamer blind. Closing of this blind was necessary in order to isolate the forward block of wing tanks in preparation for loading methanol.

The spray nozzle device was fabricated of a short piece of one and one-half inch brass pipe, fitted with a pipe cap screwed to one end and pierced at random around its circumference for its entire length with drilled holes of approximately one eighth to one fourth inch in diameter. The cap was similarly drilled with several holes. The other end was threaded with a standard pipe thread and when in use was fitted to common black rubber, cloth inserted wash down hose. The hose, also of one and one-half inch diameter, was cut in fifty foot lengths and fitted at each end with couplings. No bonding wire or grounding device was used with this hose.

There were several slight variations of this spray nozzle device. Some were fabricated ashore and purchased by shore personnel. Some were fitted with a brazed cap, but most resembled the above described device and most were made on board by the ship's personnel. The device was common to ships of the company and there were at least four of them on board the SS V. A. FOGG. The origin of the device is unknown. Experienced tanker officers have known of their existence and use on some tankships for over fifteen years.

Fresh water at a pressure of forty to seventy pounds per square inch would be applied through the nozzle device to produce a spray for washing the tanks. The actual washing procedure required two seamen to lower and raise the hose and nozzle. Washing began by lowering the hose slowly, in steps, through a Butterworth opening until the nozzle was near the bottom of the tank. The hose was then lowered and raised in a similar manner through the open hatch and through the other Butterworth opening. When washing the hatch trunk, the cover was rinsed first, then the inner surfaces of the coaming and then the ladder just below. Each drop of the hose required approximately ten minutes as estimated by the men handling the hose. In some instances a line was attached to the hose to facilitate handling when lowering or hauling out. More often the hose was used without the line. When shifting from opening to opening the hose was hauled up near the deck. The flow of water was then interrupted by one of the men crimping the hose or closing a valve until the nozzle was inserted in the next opening. After completing the washing process in the number 3 tank, the crew was ready to shift to the other side of the ship. The pumpman was then notified to stop or to slow down the pump while the hose was shifted to the number 1 tank on the opposite side. When the forward tanks were washed the washing crew could begin washing the number 7, 8 and 9 wing tanks.

Fresh water used in the tank washing procedure was supplied to the washdown hose by the forward fuel oil transfer pump located in the forward pump room. The pump took suction from the former forward fuel oil deep tanks located between frames eighty-five and ninety-nine. These tanks had been used exclusively as fresh water storage tanks in recent years. This pump discharged fresh water through a manifold and valve arrangement to the fuel oil transfer line which ran fore and aft on deck from the forward pump room riser to the after pump room. The line was blanked off just forward of the amidships cargo loading and discharging manifolds which isolated the forward section of the line from the after section. The after section was still a part of the fuel system; whereas, the part of the line forward of the blank served the fresh water tank washing system. To make the water from this

system available to the hydrants and hoses throughout the length of the ship, a jumper hose was rigged from the forward section on the line to the deck fire line. By this means the two lines were cross connected which enabled the fire main to be charged with fresh water pumped from the forward deep tanks by the forward fuel oil transfer pump. Washdown hoses could then be connected to fire hydrants or to other connections on the fire main conveniently located near tanks to be washed. The valve in the fire main just forward of the after pump room would be closed.

Stripping or removal of wash water and residual cargo from numbers 1, 2, 3, 4, 7, 8 and 9 wing tanks was accomplished by means of the deep well pumps located in the number 3 port and starboard and the number 9 port and starboard tanks. It was sometimes the practice to discharge tank washings or slops into number 9 port or starboard tanks, holding them there until the vessel was well out to sea. On most occasions instead of holding them in a tank the slops were allowed to flow from the discharge manifold onto the deck and then overboard through the deck scuppers.

Two witnesses testified that at least on one occasion a "red devil" pump was used as the sole means of stripping washings and residual cargo from a tank.

When all the wing tanks forward had been washed the crew began to wash the number 7, 8, and 9 wing tanks. This completed the normal tank washing process, consisting of fourteen tanks, in those instances when the scheduled cargo to be loaded in the 1, 2, 3, 7, 8 and 9 wing tanks was to be methanol.

The men then proceeded to clean other tanks as the anticipated cargo requirements dictated.

In any case, ventilation was begun immediately upon completion of the tank washing. After this stage of the process, the tank cleaning laborers commenced work in the tanks. It was their function to remove any other residual water and cargo from the tanks, to muck out if necessary, and to wipe the accessible internal surfaces dry with rags brought on board for that purpose.

The forward cofferdams located between frames eighty-three and eighty-five were sometimes used for fresh water storage. This water, when carried, was sometimes mixed with Gamlen Seaclean II, a commercial solvent used on board as a cleaning agent to aid in the removal of some types of residual petroleum products from cargo tanks. This mixture was not commonly used for cleaning tanks which pre-

viously had held benzene. The total capacity of these two cofferdam spaces was approximately 148 tons when filled with water. The amount of water carried in these spaces on this voyage, if any, is not known.

Tests of a spray nozzle device similar to the type used on board the SS V. A. FOGG were conducted by the U. S. Coast Guard Field Testing and Development Center at the Coast Guard Yard, Baltimore, Maryland. Flow rate tests at water pressures from ten through seventy pounds per square inch were measured. In addition, a theoretical analysis was transformed into a computer program and run for the various pressures. The results of the actual tests and the computer data output were within five percent of each other. Tests results showed that forty tons of water per hour will flow through the nozzle at a pressure of forty pounds per square inch.

Testimony of witnesses varied as to the length of time the hose and nozzle device remained in each tank. These times varied from thirty to forty-five minutes. Using ten minutes per drop and 40 pounds pressure, as a basis for calculations, twenty tons of water would be required for washing each tank. Since fourteen tanks had to be washed with fresh water a total of 280 tons of fresh water would have been needed for tank washing.

Using the figure of 170 tons obtained from abstracts of previous voyages there is a disparity of 110 tons. No allowance is made for evaporator make up water although the maximum capacity of the evaporator was approximately twenty tons per day.

Fresh water was loaded at Puerto Rico and 160 tons were on board departing Guayanilla. The amount of water loaded at Freeport, Texas, on 30 January is not known. No metering devices were used while taking fresh water at Freeport.

Total capacity of the two forward fuel oil tanks was approximately 765 tons. Forepeak capacity could provide an additional 393 tons. Records and voyage abstracts of previous similar voyages, however, indicate that the maximum water carried upon departure was 218 tons. Abstracts also indicate that total water carried on the tank cleaning passage between Freeport, Texas, and Houston, Texas, averaged 170 tons. Calculations as shown in paragraph 9b confirm that water aboard was in the order of 170 tons. These estimates include boiler feed water, domestic potable water and water reserved for tank washing.

(b) Ventilation With Coppus Blowers:

Former crewmembers and officers who had served on the vessel on previous similar tank washing, gas freeing and drying voyages recalled that the tanks after washing with the spray nozzle device would be ventilated from thirty minutes to one hour. This was done by means of steam or air driven mechanical blowers of two types, both of which are common to the tanker industry.

Turbine driven blowers used on board to ventilate the tanks were Coppus C-12 tank ventilators and Coppus CP-20 blower-exhausters. Both were manufactured by the Coppus Engineering Corporation of Worchester, Massachusetts, and there were two of each type on board.

The C-12 ventilator is designed for mounting on the ship's Butterworth opening, discharging air vertically down into the tank. The lower flange of the ventilator is drilled with ten one inch holes on a 15 5/16 inch bolt circle which allows it to be placed directly over the studs around the edge of the opening. The unit is made of steel and aluminum and is fitted with a three-quarter inch inlet and a one and a quarter inch exhaust outlet, and can be operated on steam or air.

The CP-20 blower-exhauster is a turbine powered fan also capable of operation on steam or air. It can be used as a blower or exhauster mounted in any position, and is designed to deliver 11,500 CFM at 3500 RPM at 150 PSIG. The fan speed is varied by throttling the steam or air supply. Net weight of the blower-exhauster was 117 pounds and it was fitted with lifting handles. Each of the two carried on board was mounted in the center of a sheet of about three-quarter inch plywood, large enough to overlap the periphery of the hatch trunk. They were positioned to exhaust air from the tanks, in which case air would enter a tank through the Butterworth openings. The air would enter the tank at deck level; no chutes or extensions would be installed to direct the incoming air toward the bottom of the tank.

Hoses used for the steam supply to the Coppus blowers were metal reinforced one and one-fourth inch hose, made up to the blower turbine with standard pipe fittings to accommodate the various inlet sizes. Steam supply was from the deck steam line at approximately one hundred eighty pounds per square inch. Air hoses, when used, were the common rubber reinforced, cloth inserted type. The choice or source of power to drive the blowers depended upon the availability of steam or air for the number of tanks to be ventilated. It was most common to use air to drive the

smaller C-12 ventilators and steam to drive the larger CP-20 blower-exhausters.

When in operation the C-12 ventilator exhaust steam or air was released to the atmosphere through a nipple on the blower turbine housing. Exhaust pressure was adequate to carry most of the steam and condensate clear of the blower; however, the deck near the ventilator would be wetted after a period of operation. The CP-20 blower exhaust steam or air would be carried away in the air stream of the blower.

(c) Test of Tank Atmosphere:

Cargo tanks after washing would be entered by the Boatswain, or in his absence the seaman in charge of the deck gang, who would check the condition of the tank by sense of smell. If satisfied that the air was good at the top of the tank he proceeded farther down as far as the first platform on the ladder. It was in most cases assumed that if the air was good and relatively free of odor at that level it was good in the lower area of the tank. If the air was not found satisfactory, the Chief Mate would be called to check the cargo tank with a combustible gas indicator. Use of the combustible gas indicating device was not part of the duties of the Boatswain or any other unlicensed crewman.

A combustible gas indicator is an item of required equipment on tank ships authorized to carry Grade A, B, C, or D liquids at any temperature and Grade E liquids at elevated temperatures. A combustible gas indicator shall be suitable for determining the presence of explosive concentrations of cargo carried. An indicator which bears the label of Underwriters Laboratories, Inc., Factory Mutual Engineering Division, or other organizations acceptable to the Commandant is acceptable.

The principle of operation of a combustible gas indicator is as follows: The gas sample is drawn from the compartment through a rubber sampling tube into the instrument and across a heated platinum filament. If combustible gasses, are present, they will burn on the filament, increasing its heat and electrical resistance. This change in electrical resistance is in direct proportion to the concentration of the combustible gas and is measured and displayed on the meter dial of the instrument.

Such instruments are of value if kept well calibrated and in good operating condition. Readings must be taken at all points throughout the compartments involved, especially, in areas or pockets subject to localized accumulation of gasses.

Current regulations require that an inspection be performed to insure a gas free condition exists prior to undertaking repairs or alterations, or other operations involving hot work in the vicinity of oil tanks, oil lines, etc. These inspections in United States ports are to be made by a marine chemist certified by the National Fire Protection Association. However, exceptions are made when a marine chemist is not available. When not in a United States port and no marine chemist is available the inspection may be made by the senior officer present. Current regulations for tank vessels are silent with respect to testing tanks and compartments prior to entry to perform cold work, i.e., cleaning, opening or closing valves, draining lines and pump sumps.

The SS V. A. FOGG had on board two combustible gas indicators. They were sighted by a Coast Guard inspector at the last biennial inspection in August 1971. One of the instruments was new having been placed on board within the last year. There were no provisions for testing or calibration of these instruments, either by company or vessel policy. New replacement instruments were purchased if a malfunction developed as repair was not considered economically feasible.

A company or ship formal training program was not set up to instruct ship's personnel in the operation of a combustible gas indicator or the requirements for its use. However, Coast Guard administered examinations for qualification as Master, Mate and Tankerman cover utilization of combustible gas indicators in determining the explositivity of tanks and compartments. Officers on the SS V. A. FOGG were familiar with the operation of a combustible gas indicator. However, tank cleaning and personnel entry into cargo tanks was routinely done without testing the tank atmosphere with a combustible gas indicator. Crewmembers on the SS V. A. FOGG were generally unaware that benzene vapors were heavier than air. Most were under the mistaken conception that if the upper section of the tank was safe to enter the lower portion would also be safe to enter.

The rules and regulations for tank vessels are silent as to the need for an oxygen indicator or an instrument to determine the toxic content of a tank or compartment. No such equipment is required to be carried on board.

(d) Removal of Residual Wash Water and Residue Not Removed During Washing:

Each tank was air blown or ventilated for approximately thirty minutes to one hour depending upon how long it took to remove enough fumes and gas to permit a man to enter

the tank to place an air operated portable pump, commonly called a "red devil", in the most advantageous spot for removal of any slops not removed by stripping with a deep well pump. In the event it was decided by the Mate or Boatswain that the tank was not safe to enter without special equipment, there were on board as a part of ship's equipment, two fresh air breathing masks. These devices consisted of a hood, with a hard hat attached which were fitted with a clear plastic visor to provide visibility for the wearer. Air supply was provided by means of small diameter rubber air hoses connected to the ship's service air system.

Those air masks provided by the shore labor force differed slightly in that the mask and hood were of a soft material which extended to shoulder length. The mask was open at eye level which allowed for the discharge of air. The hoses and air supply arrangement were similar to those masks provided by the ship.

The "red devil" pump was lowered through a Butterworth opening, sometimes by means of a lanyard attached to the bail cast into the pump housing. This manila line was longer than the forty feet depth of the tank, and was detachable so that it could be stowed when not in use. Rubber hoses used with the "red devil" pumps were sometimes marked with a rag or a painted ring at a point on the hose which would indicate when the pump was a foot or two from the bottom of the tank. While lowering the pump into a tank it was custom to have one man at the bottom of the tank to receive the pump so that it could be placed in the selected spot, in order to remove the remaining residual wash water and cargo mixture. It was also custom, that in cases when the tank was gassy, the man receiving the pump would be equipped with an air mask or hood.

The "red devil" pumps operate at impeller speeds of approximately 8500 RPM and are capable of removing the small amounts of residual liquid and discharging it through a hose rigged vertically to the deck forty feet above. The pumps take suction through a strainer located on the bottom of the pump housing. When in use small puddles of water and product were scooped or swept toward the pump where the liquid was picked up and rapidly discharged.

The pumps were also used to remove the estimated two or three barrels of liquid remaining in the deep well pump sumps. This process was accomplished shortly after the washing and stripping of the number 3 and number 9 tanks was completed and during the first ventilation stage. It required that a man with a wrench reach under the base of the sump between the vessel's bottom longitudinal frames to remove a

plug. The liquid mixture of cargo residue and wash water was then allowed to drain from the pump sump and to flow toward the running "red devil" pump which discharged it from the tank. Occasionally, the mixture would be rich with cargo. This would require additional buckets of fresh water to be brought into the tank to dilute and wash the product toward the pump suction.

This function usually completed the seamen's part of the task; however, there were occasions when the laborers assisted with this part of the work.

The "red devil" pumps on board the SS V. A. FOGG were air operated submersible portable sump pumps. The housing, impellers, strainers and integral fittings of those provided on board the ship were usually of non-ferrous metals. Pipe fittings for air supply, air exhaust and liquid discharge orifices were of various materials. Air hoses were standard cloth inserted rubber hoses rigged to fit the one inch air inlet; discharge hose was also standard cloth inserted rubber covered hose rigged to fit the two and one-half inch water discharge orifice. This type pump is designed to lift approximately 300 gallons per minute against a discharge head of forty feet when operating on 100 psi air. The pump operates at high impeller speeds driven by a simple rotary valve air motor. The housing is cast with a ring for ease of attachment of a lanyard or line.

One of the "red devil" pumps provided by Marine Maintenance Company was a Ramit Sump Pump P-13, made in Japan and distributed in the United States by Ram Intercontinental Trading Company, Inc., Houston, Texas. The Ramit pumps were made of bronze or brass castings. They are designed to lift 85 gallons per minute against a head of 65 feet when operating on 85 pounds air pressure. The free speed of the impeller is 8500 RPM and the weight of the pump is fifty pounds. The casing on this type pump is also cast with a ring for ease of lifting by line or lanyard.

While performing this work the shore laborers found "red devil" pumps, steam eductors, scoops and buckets which they also brought on board, useful in further ridding the tanks of water. The pumps provided by the shore laborers were of the same general characteristics as those found in ship's gear.

Air supply hoses were standard cloth inserted rubber hose fitted with steel or brass couplings. The hoses were bought in bulk, cut to fifty foot lengths in the Marine Maintenance shop, and fitted with couplings there. They were

secured to the hose by means of a "Bandit" strap. None of these "red devil" pumps were equipped with a lanyard. It was the custom of the shore laborers to rely on the hose when lowering a pump into a tank. There was no bonding, cable or other device whereby, the hoses or coupling could be grounded, nor were the men instructed in the use of such devices.

If and when used, a steam eductor, also a piece of ship's gear, was placed on deck, fitted with steam hose and suction hose. The device also served to remove small amounts of liquid residue from the tanks. To be effective the eductor suction hose was required to be moved from place to place by hand. This device, manufactured by the Penberthy Company, Prophetstown, Illinois, is also a common piece of equipment on large tank vessels. Although the maximum design suction lift of the device is twenty feet, it can, under certain conditions, lift water from the bottom of the cargo tank to the deck forty feet above.

(e) Wipe Dry With Rags:

It was the function of the laborers to enter the cargo tanks to remove any residual water and slops from the tanks, to muck out if necessary, and to wipe the accessible internal surfaces dry with rags brought on board for that purpose. Approximately ten to fifteen minutes per tank were required to complete this stage of the process. The work was performed by one or two men in each tank, depending upon the amount of water present. Generally, the labor foreman remained on deck at the tank hatch as a safety man. Depending upon the strength of fumes in the tank, in the judgment of the labor foreman, the men were or were not required to wear air hoods provided by their employer. Upon completing one tank the men would move to the next tank and continue work through the night until the vessel arrived at Houston, Texas. There, a relief gang of ten laborers would board the vessel to complete any unfinished wiping and drying.

(f) Additional Ventilation:

After the laborers had completed their work, the blower-exhausters were used to further ventilate the tanks and reduce the moisture and gas content to the degree where it would satisfy the petroleum inspector at the loading port.

After removal of the blower-exhausters, the tank hatch covers were left open about four inches to provide adtional ventiiation.

12. Characteristics of Benzene Under Shipboard Conditions:

Benzene is a colorless, water white liquid with a pleasant aromatic odor. It has a boiling point of 176°F, a freezing point of 42°F, and a vapor pressure at 68°F of 75.1 millimeters of mercury. Benzene evolves sufficient vapor to be ignitable at 12°F (flashpoint, closed cup). Below the freezing point (42°F) benzene sublimes, going directly from the solid phase to the vapor phase. Its vapor is 2.80 times heavier than an equal volume of air. However, at 20°C the specific gravity of the benzene-air mixture is 1.16. Benzene floats on the top of water since it is nearly totally immiscible with water and has a specific gravity of 0.88.

Benzene is a stable compound. It is highly flammable and its vapors form explosive mixtures in air. The range of vapor concentrations (percent by volume in air), which will burn or explode if an ignition source is present, is 1.4% (lower explosive limit, LEL) to 8.0% (upper explosive limit, UEL).

The volume percent of benzene vapor in air can be calculated by dividing the vapor pressure of benzene at a particular temperature by atmospheric pressure. Volume percent so obtained can be plotted against temperature to provide a graph. That graph will show that the lower explosive limit of 1.4% corresponds to a temperature of 12 degrees F., the lower flash point of benzene. Similarly, the upper explosive limit of 8% corresponds to a temperature of about 61 degrees F. Put another way, an empty cargo tank containing benzene residue in equilibrium with its vapor would be in the explosive range should the temperature in that tank be between 12 and 61 degrees F. It is here again worthy of note that on the day of the casualty the ambient temperature was 49 degrees F., and sea temperature was about 56 to 61 degrees F.

With respect to static electricity, the following comments appear in the current edition (third revision 1960) of the Chemical Safety Data (Sheet SD-2) published by the Manufacturing Chemists' Association Inc., 1825 Connecticut Avenue, N. W., Washington, D. C.:

"Sparks from static electricity will ignite benzene vapor and air mixtures.

"Benzene flowing through or being discharged from a line generates static electricity and effective grounding of the line is necessary to prevent possible ignition.

"Before benzene is poured or discharged from one metal container to another, the two vessels should be grounded

and electrically interconnected. All metal surfaces with which benzene comes in contact should be grounded and bonded so that the resistance to ground is not greater than five ohms."

The inhalation of benzene vapor can be deleterious to health and should be avoided. The susceptibility of individuals may vary, but the maximum concentration believed to be safe for eight hours' exposure daily, five days per week for prolonged periods, is 25 parts per million by volume in air. This Lower Threshold Value (LTV) for benzene has been accepted by the American Conference of Governmental Industrial Hygienists (ACGIH).

The following comments on exposure to benzene appear on pages 395 and 396 of volume 3 of Kirk-Othmer, Encyclopedia of Chemical Technology, Interscience Publishing Company, a Division of John WILEY & Sons, Inc., New York, London, & Sydney (1964):

"... The body develops no tolerance to benzene and any damage can be cumulative and permanent. There is wide variation in the susceptibilities of individuals. Women appear to be more susceptible to benzene poisoning than men, and young persons more than older persons. Individuals suffering from anemia, respiratory diseases, alcoholism, heart disease, kidney disturbances, and obesity are also more subject to benzene poisoning. Very efficient ventilation is required when working with benzene in an enclosed space. The wide use of adequate ventilation has made possible the safe handling of the enormous quantities of benzene consumed in industry.

"Depression of the central nervous system results from inhalation of high concentrations of benzene vapor for short periods of time, often a matter of minutes. As a result, paralysis of the respiratory center and asphyxia may cause death. The effects are rapid. The first symptoms are tightening of the leg muscles, dizziness, excitement and pallor, followed by flushing, weakness, headache, breathlessness, apprehension of death, and constriction in the chest. The pulse becomes rapid, and the color blue. Visual disturbances, tremors, and muscular weakness are encountered. The victim may lose consciousness and pass into coma. Convulsions are fairly frequent. Death may occur almost at once or several hours to several days following exposure. In advanced cases of acute poisoning, the patient becomes confused and hysterical and may laugh, shout, or sing.

"Exposure to air containing benzene in a concentration of 19,000-20,000 ppm causes death within a few minutes;

concentrations of 7,500 ppm are dangerous to life in one half to one hour. The drinking of benzene produces symptoms similar to those following inhalation of like amounts of the substance, plus local acute irritation of the mouth, throat, esophagus, and stomach.

"Chronic benzene poisoning usually results from daily exposure to unsafe concentrations of vapor over a prolonged period (weeks or months), but may also result from a single, concentrated exposure. If chronic benzene poisoning has begun, the effect may be indicated by a decrease in the number of red blood corpuscles, white blood corpuscles, and plateletas; however, an increase in the number of white blood corpuscles has been observed in some cases. Immature blood cells, not usually found in the peripheral blood, may also be observed. Chronic benzene poisoning affects the blood-forming function of the bone marrow. If bone marrow damage is slight, complete recovery usually occurs after removal of the individual from exposure to the benzene. If the damage is severe, the poisoning is usually fatal since no method is known for restoring the ability of bone marrow to manufacture the necessary blood constituents. Since many of the symptoms of benzene poisoning are also characteristic of other disabilities, the fact of exposure to benzene must be established before a valid conclusion of benzene poisoning can be drawn. Because the symptoms are so ill-defined and erratic, any change in the blood picture of workers exposed to benzene should be viewed with suspicion.

"Skin contact with benzene results in defatting of the skin and may lead to the development of dry scaling and the formation of vesicular papules. Absorption of benzene through the skin can also result in poisoning; immediate changing of bandages or clothing wet with benzene is important."

Benzene does not have good warning properties; i.e., detection by smell occurs at vapor concentration higher than the Lower Threshold Value. Its odor threshold, which is defined as the smallest concentration that can be detected by smell by most people, is 100 ppm, of benzene by volume in air. Good ventilation is essential in compartments or areas where benzene is handled to prevent the accumulation of toxic or explosive mixtures.

Officers and crew aboard the SS W. A. FOGG were exposed to inhalation of benzene vapor in several different ways whenever that cargo was carried. Loading of benzene into the cargo tanks was accomplished in the same manner as for conventional petroleum cargoes. Ullage openings located on top of tank hatch covers afforded the means for venting vapors being dis-

placed from the tanks. Level of cargo in a tank during loading would be determined by standing by an ullage opening and visually sighting into the tank, with resultant, direct exposure to vapors being displaced through the ullage opening. Vapors thus released about the deck area would or would not rapidly disperse depending upon direction and velocity of the wind. Furthermore, if the wind was in the right direction, benzene vapors would be picked up by the air conditioner intake and dispersed throughout the living quarters where the fumes were found objectionable and caused headaches. Upon completion of loading, gauging of cargo tanks would be accomplished through the ullage openings.

Exposure to benzene vapors also occurred in the pump room during discharge of this cargo, even though mechanical exhaust ventilation was provided. Defective, or worn, seals in the shaft packing glands of the cargo pumps allowed benzene to collect in the pump room bilge. On one occasion benzene cargo to a depth estimated at eight inches was observed. Even though the crew were uninformed on properties of benzene vapors, during discharging operations they considered the pump room safe to enter, for only a few minutes at a time and with a safety man standing by topside because of benzene fumes.

Exposure to benzene vapors in varying concentrations also occurred during the cleaning of cargo tanks. Dispersal of benzene vapors discharged about the deck area by Coppus blowers was dependent upon wind velocity and direction. Overboard discharge of benzene water slops by the deep well pumps occurred:

(a) at the main deck crossover manifold piping, where the slops were allowed to run directly on deck, or

(b) into piping extending towards the side of the vessel, or

(c) into piping (overboard chutes) extending over the side of the vessel where some spray back occurred. In all such cases benzene, or benzene vapor, could be swept by the wind over deck and quarters.

The odor of benzene was often detected in the after living quarters during tank cleaning operations, and if the odor became strong enough no smoking was permitted inside the quarters as well as outside.

Exposure to benzene in varying concentrations occurred, depending upon the extent of personal protective gear worn, during tank entry to use "red devil" portable pumps for discharging water and benzene residue, while changing Weco/Hamer

blinds, while removing plugs from bottoms of deep well pumps, and while wiping the tanks dry.

Exposure to benzene vapor would also occur during the ballasting procedure. For example, center tank number 2 of the SS V. A. FOGG was ballasted prior to leaving the Phillips terminal at Freeport. This addition of water ballast to near the deck level meant that residual benzene vapor inside the tank was forcibly displaced, through the pressure/vacuum relief valves or more probably through open tank hatches, into the air space near the main deck. From there the vapors would be dispersed by whatever wind action was taking place. In effect, this tank was gas freed to a considerable extent while the vessel was still at the dock. No special precautions were taken with regard to harmful effects which might accrue to ship's personnel as a result of exposure to the vapors.

13. Electrostatic Phenomena:

The washing of cargo tanks by Butterworth machines and other devices is accomplished by directing streams of water against tank internal boundaries. Water streams, upon striking such surfaces as the overhead, bulkheads, bottom, and associated strength members will splash and break apart into droplets. This process of breaking water apart into droplets results in a mist which fills the entire tank. The mist, otherwise known as an aerosol, can be more readily understood by noting it is like that obtained when one takes a shower in a closed bath room. The streams of water from the showerhead will splash and form water droplets of different sizes. The larger droplets are heavy enough to be affected by gravity and of course will fall. Smaller droplets, however, are formed which are too small to fall. They are affected by all aerodynamic motion in the air and fill the room as a mist. The appearance of a mist as commonly observed after taking a shower in a closed bath room, and as would be observed inside a cargo tank after it has been washed with fresh water, is one and the same.

One well recognized aspect of water droplet formation is that the mist formed will be electrically charged. Fresh water makes a mist with a negative charge, normally known as the Leonard effect, because he investigated it at waterfalls in the late Nineteenth Century. Salt water can make a mist with a positive polarity. The addition of chemicals can change the polarity, and current studies into tanker explosions are considering the possibility of chemical additives which could reduce the polarity to zero.

The formation of an electrically charged mist inside a cargo tank during the washing process is very easy to accomplish. Most any tank washing process involving the breaking up of water into droplets can form a mist inside the tank. Even the application of a single stream of water at thirty pounds of pressure through a garden hose would in due time be sufficient for formation of the mist. The ease at which a mist is formed is dependent upon factors such as the length of time wash water is applied, the number, size and velocity of streams of water applied, water temperature, the angle of impingement on tank surfaces, and the condition or smoothness of the tank surfaces.

One factor considered quite important in the water washing of cargo tanks is that a negativity charged mist, as made by fresh water, is much more hazardous then a positively charged mist. This factor is being emphasized in discussions between oil tanker people and experts currently studying electrostatic effects and large tanker explosions.

In the case of the SS V. A. FOGG casualty, the above comments on mist formation become significant in light of statements made in the 30 November 1971 Interim Report of the American Petroleum Institute's Tanker Accident Study Committee. That report advises that experiments and considerable data that have been obtained during the past two years, both in the United States and aboard, have shown one circumstance in which an electrically charged mist might lead to a hazardous discharge. Namely, an electrically isolated object in contact with the mist could accumulate charge and might subsequently release it in a single spark to ground. The report goes on further to say that this situation can be hazardous in a flammable atmosphere because of the concentration of the energy in the spark. An isolated body could arise in a number of ways.

For example:

(1) A man lowering a rope or gas sampling hose into the tank. If his footwear or the deck coating is a good insulator, he could be charged by contact with the mist via the line. It has been shown that the rope or hose can, under shipboard conditions, have sufficient conductivity to permit charging of the man in a few seconds.

(2) A portable cleaning machine left hanging in the tank on a dry rope but with the hose containing the bond wire disconnected.

(3) Possibly, an object falling in the tank which may accumulate charge during its fall.

It is noted that the API report speaks to an electrically charged mist created by the high velocity water jets of tank cleaning machines. As developed by the Board during testimony by an expert in electrostatics who participated in development of the API report, the charged mist need not necessarily be created by high velocity water jets of tank cleaning machines. The significant point is that an electrically charged mist might lead to a hazardous discharge, irrespective of the method or machine used to create the mist.

It is especially noted that cargo tank number 3 port was one of those that exploded, and that after the casualty a portable, "red devil" pump with a cast steel outer casing was found in that tank. No lanyard was attached to the pump. The air supply and pump discharge hoses, which showed no sign of burn damage, were attached and extended upwards through the after Butterworth opening located inside the shelter deck. The hoses were made of black rubber, with an outside red rubber cover, and contained no wire for grounding the pump. Upon removal from the vessel four months after the casualty, the pump showed no sign of damage and the impeller could be rotated easily by hand. The pump had a strong odor comparable to benzene and droplets of an aromatic, volatile liquid were found inside the pump after partial disassembly.

The Board in pondering the loss of the SS V. A. FOGG devoted considerable time and effort to studying the possibility of hazardous electrical discharge from the various equipment used during washing, gas freeing and drying of cargo tanks. In addition to the aforedeveloped possibility of the portable "red devil" pump serving as an isolated conductor in an electrically charged mist, the following were items of deliberation.

(a) Coppus Blower:

The large capacity blowers on the SS V. A. FOGG were too big for effective use on deck over Butterworth holes, as was the case with the smaller blowers. To exhaust air and vapors from a tank the large blower was mounted on a plywood support which was placed over the tank hatch opening. The net effect of this arrangement, with respect to electrical hazard, was to provide a wooden insulator between the blower and the tank vessel. Electrical continuity would therefore have to be achieved by some other means than by direct contact between blower casing and the vessel. Should the blower be driven by dry air rather than wet steam a hazardous condition might arise. If the air hose were not

grounded, the blower when used to exhaust a tank containing a mist could act as a Van der Graaff machine (electrostatic generator).

(b) Perforated Brass Nozzle Tank Washing Device:

The typical nozzle used for fresh water washing of cargo tanks that had carried benzene was made of brass, and the rubber hose to which it was attached contained no grounding wire. That no grounding wire was provided is especially noteworthy in view of tanker operating practices which prescribe that Butterworth machine hoses always be equipped with grounding wires, and that they be checked for electrical continuity before use. It therefore appeared that the following might take place during fresh water washing of a cargo tank with the perforated brass nozzle:

While washing, the brass nozzle could serve as an accumulator of an electric charge. However, the column of water inside the hose would act as a conductor and effectively bleed off the charge as it accumulated on the nozzle. Should the flow of water be interrupted, such as by disconnecting the hose or closing the valve at the hydrant, electrical continuity as provided by a column of water would be broken. Water as it drained might cause the nozzle to accumulate a charge of sufficient strength to produce an incendiary discharge to ground should the nozzle come close to part of the tank.

14. The Search for SS V. A. FOGG:

A. Events Prior to Search for SS V. A. FOGG:

At about 1610, 1 February a National Aeronautics Space Administration pilot in the area sighted a large rising mushroom shaped dark cloud over the Gulf 48 miles bearing 151 true from the Galveston Vortac. The cloud at one time was about 1½ miles wide by three miles long and 8,000 feet high. His smoke sighting was immediately reported to Houston Control Center who relayed the information to Ellington Coast Guard Air Station. About the same time a commercial airliner identified as Mexicana 801 reported a smoke sighting 65 miles bearing 165 degrees true from the Galveston Vortac. This information was also relayed to Ellington Coast Guard Air Station. The Coast Guard Rescue Coordination Center in New Orleans was advised of the smoke sightings and assumed operational control of the incident. At 1627 Corpus Christi Coast Guard Air Station was alerted by phone for a possible aircraft launch. At 1647 the Rescue Coordination Center ordered the launch of a search aircraft. The aircraft, a UF 16, was airborne at 1708 and was directed to

check out the two positions of smoke sightings. The aircraft was on scene at 1800 with radar operating. The heavy smoke cloud was sighted and the pilot flew back and forth through the smoke four or five times at an altitude of 500 feet and lower. A Charlie Sierra creeping line search was conducted and continued for over two hours. The origin of the smoke could not be determined and nothing was sighted on the surface of the water.

The choice of a UF 16 type aircraft in lieu of a Houston based helicopter was predicated upon greater range and endurance of the UF 16 aircraft. Time of day and visibility were also factors considered.

The air search made on 1 February did cross the position where the hulk of the vessel was eventually found. Due to darkness the air search of 1 February was suspended. On the morning of 2 February a Coast Guard aircraft again searched in this general area for a period of two hours and forty-five minutes. Nothing of any significance was sighted that would explain the origin of the smoke sighted the day before.

At 2130 1 February Mr. Mackay T. CONARD attempted to communicate with the vessel in order to establish a firm ETA via the Houston Pilot's VHF radio. This attempt was fruitless. At 2200 a second attempt was made via Radio Marine and the marine operator and again this was unsuccessful. At 0600 on 2 February Mr. CONARD placed a cable with ITT World Communications for the vessel to advise ETA. This cable too was unanswered.

B. Overdue - Notification:

At 1430 on 2 February Mr. CONARD of Texas City Tankers notified the Coast Guard of the overdue SS V. A. FOGG.

The dispatch of a Coast Guard aircraft on 1 February and the morning of 2 February, to examine the area where the large smoke column was reported by the National Aeronautics Space Administration pilot, had not been correlated by the Coast Guard Rescue Coordination Center, New Orleans with the disappearance of the vessel. After the vessel overdue report, the column of smoke as noted on 1 February was associated with the overdue status of the SS V. A. FOGG.

C. Search After Notification:

On the afternoon of 2 February two Coast Guard Search aircraft were launched and Coast Guard surface search vessels were sent to search for the overdue vessel.

Rescue Coordination Center, New Orleans generated a third position latitude 28°17'5"North, longitude 94°38" West. This position,which was down the fairway from Freeport, Texas, was based upon the approximate speed of the SS V. A. FOGG, time of departure from Freeport, and time of the smoke sighting as given by the National Aeronautics Space Administration pilot.

During the next ten days there were several surface and air searches that did cross the three positions. A search was made on the fifth and sixth of February with a Navy plane equipped with Magnetic Anomaly Detection equipment, but the search area was to the Southeast of the wreck of the SS V. A. FOGG.

Planned resources for searches coordinated by Commander Eighth Coast Guard District for SS V. A. FOGG were:

DATE	AIRCRAFT	VESSELS
1 Feb	1	0
2 Feb	3	2
3 Feb	8	4
4 Feb	6	6
5 Feb	6	3
6 Feb	9	3
7 Feb	7	3
8 Feb	3	1
9 Feb	3	1
10 Feb	2	1
11 Feb	1	1

During search operations the actual aircraft resources utilized conducted 71 sorties consisting of 336 flight hours. The surface resources utilized during search operations conducted 9 sorties consisting of 532 operating hours.

Debris consisting of a 10-man inflatable raft, a wooden door, a life preserver with a money belt tied to it, a life ring, a burned lifeboat storage box, and a few other items identified as coming from the SS V. A. FOGG were recovered during this search period. The active search was continued until the hulk was located. The vessel was located on 11 February by employees of the "GAIGMX" of EG & G International aboard the M/V MISS FREEPORT using a EG & G Mark 1 Side Scan Sonar. Divers employed by the vessel's owner positively identified the wreck on 13 February. Its location is latitude 28°35'34".70 North, longitude 94°48'44".22 West in about 100 feet of water.

The weather prior to 1 February off Galveston had been fairly blustery with North and Northeast winds. These influences along with the normal current for this area resulted in a two to three knot current running towards the Southwest at or about the time the SS V. A. FOGG was lost. This evaluation of current was a factor in the search planning. Accordingly, after a few days the surface and air search for survivors was in areas to the Southwest of the place where the SS V. A. FOGG was finally found. A second factor in the search planning which was used by the Coast Guard Rescue Coordination Center in New Orleans, was the advice from the company representatives to the effect that the normal practice of the Captains of these vessels was to proceed directly out the Freeport fairway until they were 50 miles or more off the coast. The SS V. A. FOGG was not on the Freeport fairway at the time of the explosion and sinking, nor was it 50 miles offshore.

The SS V. A. FOGG was not equipped with devices which would have aided searchers looking for a vessel sunk on the Continental Shelf in relatively shallow waters. There is no requirement for a U. S. vessel to carry or be equipped with:

(a) An emergency position indicating radio beacon device or

(b) A sonar beacon device to be actuated by immersion.

Shortly after the casualty, while the Marine Board of Investigation was in public session the Coast Guard Marine Inspection Office at Galveston, Texas, canvassed local and nearby fishing fleets in an attempt to locate witnesses who saw smoke or fire or who might have heard an explosion near the location of the wreck. No fishermen, boatmen or other mariners were found who witnessed the incident. Two residents of San Luis Pass, Texas, heard a noise somewhat later on the same day. The Board did not relate their testimony to the casualty.

An inquiry of nearby universities and government installations equipped with seismic detection equipment failed to provide evidence that an explosion or detonation was recorded on the afternoon or early evening of 1 February.

15. Personnel:

The following advice on employee education and training appears in the current edition (third revision, 1960) of the "Chemical Safety Data Sheet SD-2" published by the Manufacturing Chemists' Association, Inc.:

"Safety in handling benzene depends, to a great extent, upon the effectiveness of employee education, proper safety instruction, intelligent supervision and the use of safe equipment.

"The education and training of employees to work safely and to use the personal protective equipment or other safeguards provided for them is the responsibility of supervision. Training classes for both new and old employees should be conducted periodically to maintain a high degree of safety in handling procedures. Workers should be thoroughly informed of the hazards that may result from improper handling of benzene. They should be cautioned to prevent spills and thoroughly instructed regarding proper action to take in case they occur. Each employee should know what to do in an emergency and should be fully informed as to first aid measures.

"In addition to the above, employee education and training should include the following:

(a) Instruction and periodic drill or quiz regarding the locations, purpose, and use of emergency fire fighting equipment, fire alarms and emergency shutdown equipment such as valves and switches.

(b) Instruction and periodic drill or quiz regarding the locations, purpose and use of personal protective equipment.

(c) Instruction and periodic drill or quiz regarding the locations of safety showers, eye baths, and bubbler drinking fountains, or of the closest source of water for use in emergencies.

(d) Instructions to avoid all unnecessary inhalation of vapors of benzene and all direct contact with the liquid.

(e) Instructions to report to the proper authority all equipment failures and/or signs of illness of employees exposed to benzene."

In the Secretary of Treasury's Committee on Tanker Hazards Final Report of 14 August 1963, Chairman, Professor H. L. SEWARD made comments on crew training. The Board reviewed the 1963 report, including pages 30-32 which are quoted below:

"B. Personnel

"As a result of its studies, this Committee

feels that, while some problems exist in materiel matters, these are over-shadowed by the problems concerning personnel. This is particularly true in the area of personnel training, which frequently appears to be inadequate in such subjects as: - the dangerous properties of cargoes, safety requirements and best practices, and knowledge of USCG and company regulations. The opportunity for the correction of this lack of training lies open to both organized labor and management.

"No person should be allowed to "turn to", and go on duty unless and until he has taken instruction from qualified teachers in the fundamental safety and fire protection measures, particularly those applicable to tanker operations, and understands both USCG and company regulations pertaining thereto. Rigid enforcement and repeated emphasis of these matters is essential.

"Many companies are doing a commendable job in personnel training and have issued good regulations and operating manuals. Eternal vigilance in the enforcement of these procedures is necessary. It is noted with satisfaction that some companies enjoying a low rate of employment turnover insist on the thorough indoctrination of every newcomer, both for his own safety and that of all on board. How much more essential it is that such indoctrination be assured where a high rate of personnel turnover prevails.

"There seems to be no formalized system for assuring that men assigned from a union hiring hall for tanker service have been indoctrinated with even the minimum knowledge necessary for safe conduct aboard a tanker. It is recognized that the more experienced members of the crew may take the new man in hand, but dependence upon this method of instructing a new man is not enough, especially with the numbers of new products now being carried.

"It is understood that the hiring halls assign a man to a tank vessel with the same procedure used for cargo ships. The men assigned to tankers should have qualifications different from those of men assigned to dry cargo and passenger ships, reflecting their knowledge of the peculiar and inherently hazardous operation associated with tank vessel operations.

"There should be a record of previous tanker experience of the man possessing it. If he never has had such experience he should be provided with the necessary facts and a knowledge of these pertinent regulations. Emphasis should be placed strongly on the constant awareness at all times of the regulations and this should be repeated frequently.

"A form of documentation through certificates should be devised to assure all concerned that this man has been initiated in the requirements of safety, possibly by endorsements on his certificate. Repeated check-ups and information on any revision of, or the additions to the regulations should be provided.

"Any infraction or carelessness should be recorded and appropriate action taken by the Coast Guard. It is hoped that those men who habitually are careless and accident-prone can be weeded out for the good of all hands.

"Instruction in the requirements of safe practices should be organized (a) afloat and (b) ashore.

"Meetings of safety committees aboard tank vessels for officers and men are found to vary from the quite perfunctory or negligible to the vigorous and productive types. The USCG inspectors should examine carefully the minutes of these safety meetings and keep a continuous record of the ships as to the frequency and quality of the meeting."

16. Damage Survey:

An extensive underwater survey of the vessel was conducted by divers employed by the Coast Guard and the owners. About 13 hours of video tape and movies were taken of the wreck. An internal and external damage assessment was made including a survey of emergency fire fighting and lifesaving equipment. Operating machinery and control systems were also examined to the extent possible to determine conditions at the time of the casualty. The bridge clock and two navigation chronometers were recovered. The bridge clock stopped by reason of physical shock at 1545 local time. The chronometers both stopped about 1547½ local time by reason of being immersed in water. The chronometer error is not known as the rate book was not found.

The vessel now lies on a heading of 131° True. The steering gyro repeater stopped on 094° and steering control lever was found on "Auto". The rudder angle indicator shows 6 to 7 degrees right rudder. The radio telephone switch was on and the radar switch was off. The bridge engine order telegraph lever was on full ahead and the answer indicator was also on full ahead. The general alarm switch in the wheelhouse was found in the off position. The gyro compass power failure toggle switch was in the on position.

Damage to the radio room and equipment was severe. The equipment, furniture and bulkhead panels were found to be a

mass of wreckage with most of the equipment adrift from their mountings.

The emergency shutdown for ventilation and the main control valve for the fixed CO_2 fire extinguishing systems were undisturbed. The main stop valve for the steam smothering system was found closed. The emergency lifeboat radio was found strapped in its rack in the athwartship passageway in the after house. The engine room engine order telegraph handle was found in its lowest position which is "Standby". The answer arrow was on half astern. Main propulsion engine control levers were all in the forward position.

The boiler burner fronts, casings, uptakes and breechings were found intact. There was no evident rupture of piping or dislodgment of equipment or floor plates in the fire room. Two burners were found in each boiler front. The Bailey Board was intact and the Master Control was set on "Auto".

There was loose insulating material or other white particles floating about the boiler and machinery spaces. The watertight door between the fire room and the engine room was open.

The paint on the forward bulkhead of the after house was scorched. Similar scorching was noted on the starboard side of the after house but there was none on the port or after sides. The forward side of the amidships house appeared lightly scorched. The damage to the after bulkhead at the break of the forecastle head shows evidence of longer exposure to heat and fire. This bulkhead is rippled and buckled. The steam smothering valves installed on the bulkhead are also burned or blown away. Some of the cargo tank pressure vacuum relief valves are completely missing having been blown or burned away. Of the pressure vacuum valves that remain, those on the foredeck show evidence of fire damage. Louvers and flame screens are burned away. Deck fittings were scorched and burned on the after sides producing a silhouette effect extending from the number 3 port tank diagonally across the deck, toward the forecastle head. There were items of tank cleaning equipment such as hoses, blowers, etc., strewn in disarray about the foredeck. The deep well pump turbines on the foredeck have been blown from their foundations and are missing as are those in way of the number 9 wing tanks. Numerous valve wheels, reach rods and fittings are damaged, distorted or blown from their original positions. Of the nine cargo tank hatch trunks forward of the amidships house only the number 2 center tank hatch cover was found dogged down in the closed position. The remaining covers are either missing or have been swung aside in the open positions.

Butterworth openings except those on number 2 center were found with covers missing; some with all studs intact and others with one or two studs damaged.

A "red devil" portable pump with two hoses attached, but without a lanyard was found in number 3 port cargo tank after the casualty. The pump was located at the bottom of the tank between two upset bottom frames. The air supply and discharge hoses for the pump led into number 3 port cargo tank through the after Butterworth opening located in the shelter deck.

When the pump was recovered the impeller was free and would turn at the touch of a finger. The pump was the steel casting type Chicago Pneumatic CP 20 pump. No external damage was noted to the pump or to the attached hoses. It could not be determined if this pump was one brought aboard by the shore laborers employed by Marine Maintenance Company or if it was a part of the vessel's tank cleaning equipment.

The discharge chute or portable piping arrangement used by the vessel to discharge slops or tank residues overboard from the cargo manifold was located by divers near its usual stowage location in the shelter deck.

Hull damage was extensive. The starboard side shell plating is generally blown out in way of all starboard wing tanks and the vessel is open to the sea from the forward cofferdam to the after cofferdam. The port side is similarly blown out and open in way of number 2, 3, 4, 5, 6, 7, 8, and 9 wing tanks. Bottom plating in way of the number 7 tanks is also missing and all that remains in this area is the broken center line vertical keel and three adjacent longitudinals on each side of the keel. The main deck over number 6 and 7 tanks is missing from the vessel and some of this plating was found about 300 feet aft of the wreck. Sections of deck plating from number 8 and 9 starboard tanks including deep well pumps, bitts and tank hatches were also found some distance astern of the vessel.

The deck plating in way of numbers 6, 5 and 4 port tanks was blown forward, up, and over the port boat deck and bridge wing. The bridge wing was sheared off at the wheelhouse door. The port lifeboat was crushed under this section of deck plate. There is massive internal damage. Structural transverse and longitudinal bulkheads throughout the ship have been holed and distorted no longer providing any degree of segregation. The forward and after pump rooms are relatively undamaged.

Throughout the living spaces there was extensive damage to internal bulkheads, furniture, fittings, paneling. Items of crew's personal gear were adrift in these spaces rendering it difficult for divers to enter. Scorching of paint is evident in way of some air conditioning and heating vents. There is scorched paint inside the athwartships passageway outside the Chief Engineer's stateroom and there is minor fire damage near open doors and ports on the forward end of the after house.

Some fire hoses were out of their racks and strewn about the decks, others were in their racks with valves closed and nozzles attached. Several of the fire hoses were found charred with parts of their canvass covering burned away.

There is no area of the open deck which has not sustained some degree of damage. This is particularly true of those areas of the main deck in way of the cargo tanks.

Lifeboats:

Of the four metal lifeboats required to be carried on board the SS V. A. FOGG by its Certificate of Inspection none survived the casualty intact. The two boats carried amidships were located after the incident. The starboard boat was found beside the hull near the bottom, resting upright on a section of shell plating that extended horizonally from the hull. It was outboard and below its normal stowage position, holed and badly damaged. The port boat was found in its chocks extensively damaged and crushed under a section of after main deck plating. The after boats were missing and have not been located. All davits were damaged; some were adrift and torn loose from their foundations. None were found in the cranked out position. The manila boat falls were either broken or burned away.

Inflatable Rafts:

Two approved inflatable life rafts were carried on the vessel. A ten person raft was installed amidships on the boat deck, aft of the house, and a twenty person raft was installed on the after boat deck. Both of the rafts were of the float free type, stowed in racks and fitted with operating lanyards secured to a staple on the rack. The float free type raft is designed and installed so that when submerged it will float free of the vessel, inflate automatically and rapidly rise to the surface ready for use.

The ten person raft was recovered by a Coast Guard search vessel during search operations in the Gulf of Mexico on 8 February. It was found inflated and undamaged. All equip-

ment was intact and appeared not to have been used. The twenty man raft was found on the beach at Padre Island on 16 March by the National Park Service Rangers. When found this raft was open but deflated and partially buried in the sand. It appeared to have floated in on the beach several weeks prior to discovery. The sea anchor and the rubber envelope for the emergency inflation pump were the only equipment found with the raft. There was no fire damage to either raft.

When recovered the ten person raft had a strong aromatic odor and a dark coating similar in appearance to bunker C over its exterior surfaces. The twenty person raft had a similar dark coating.

Life Preservers:

Life preservers were found adrift in various compartments throughout the vessel. A life preserver was not found on any of the three bodies recovered from the vessel. The one life preserver recovered among floating debris was identified as having come from the SS V. A. FOGG.

Only by viewing the vessel or the exhibits to this report can a true appreciation of the extent of vessel damage be gathered. To help the reader appreciate the gross damage an artist's interpretation is attached. This interpretation does not claim complete accuracy but is illustrative of the massive damage sustained by the vessel. Attached for reference purposes is a photograph of the vessel taken prior to the casualty.

V.A. FOGG DAMAGE

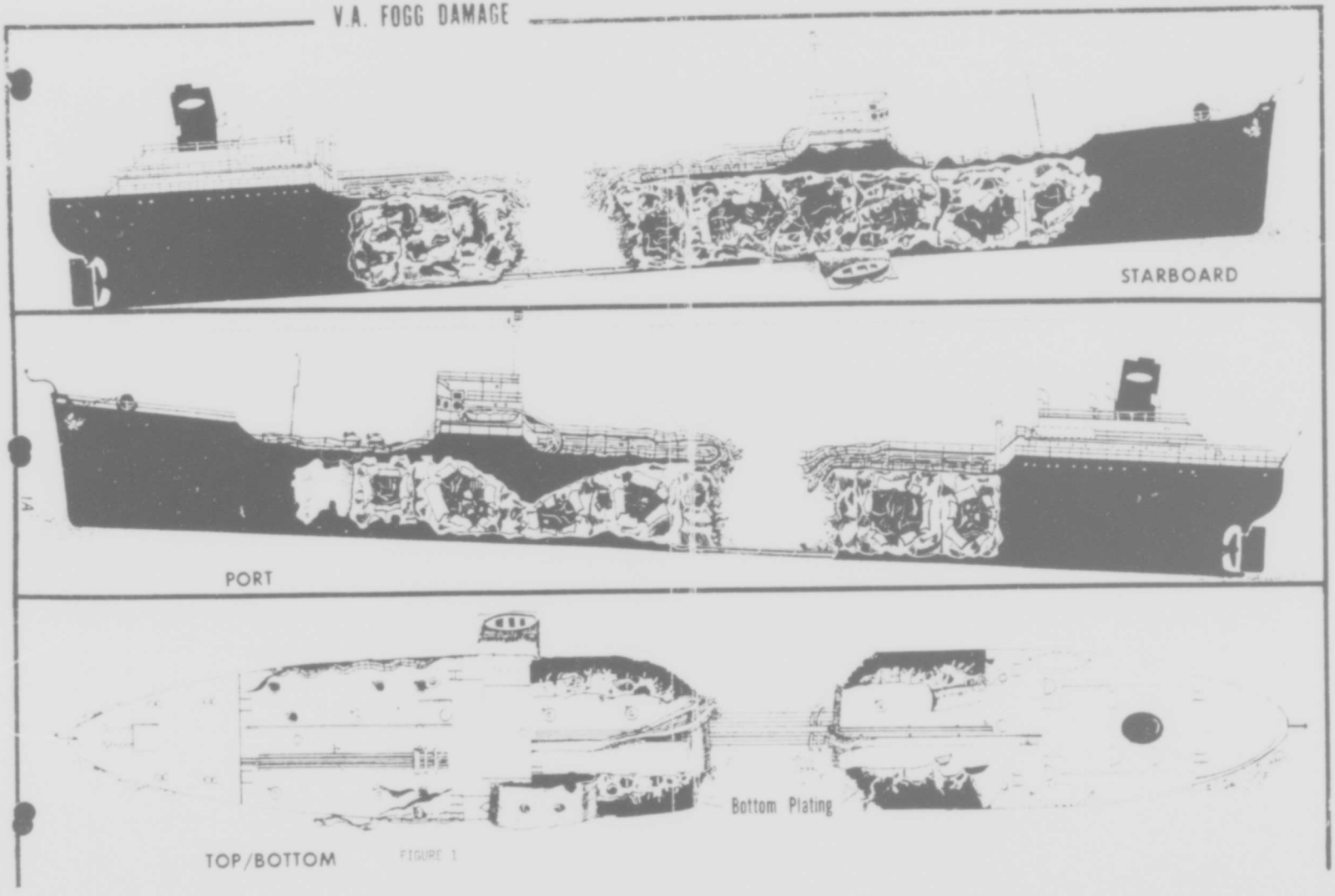


FIGURE 1

FIGURE 2

Preface to Conclusions

An examination of a vessel after an explosion will rarely lead to a definitive conclusion concerning its cause or point of first ignition. An examination of other accidents, such as collisions, groundings, and personal injuries frequently reveal the cause of the accident to be from the failure of a human to follow the norms and standards for safe operation. Similarly, the possibility of human error cannot be completely eliminated here. However, the Board did note with dismay that the tank cleaning operation as was being carried out at the moment of disaster was fraught with utmost hazard. Specifically noted and considered most germane to an understanding of a possible cause of this casualty is the fact that portable dewatering equipment was being used in number 3 port cargo tank (which exploded) before the tank had been gas freed sufficiently to bring the benzene-air mixture to below the explosive limit.

Notwithstanding the large amount of publicity this incident was given in the press, radio and television, and in spite of a canvass of the fishing fleets in Galveston and other other nearby ports, the Board was unable to locate any eye-witness to the casualty. Therefore, an understanding of what possibly occurred aboard the vessel on the day it was lost necessarily had to be developed by interrogation of seamen who had served aboard the vessel and were familiar with its construction, equipment, and operating routines. Additional information was obtained by interrogation of company officials, review of motion pictures and video films produced by divers employed by the Coast Guard and the vessel's owners, and by study of equipment recovered from the vessel. The Board also visited two tankships, comparable to the SS V. A. FOGG and owned by the same company, to obtain a better understanding of vessel equipment and layout.

Some of the following conclusions include a reference in parenthesis to a part of the Findings of Fact; e.g.,10. (3d) means part 3d of the Findings of Fact is relevant to conclusion 10.

Conclusions

1. No specific cause or explanation of this casualty, whether accidental or deliberate, in the opinion of the Board is supported by enough evidence to be listed positively as the single actual cause.

2. The Board attempted to classify possible causes of sinking of the SS V. A. FOGG. A key word guideline with the Board's conclusions as to probable cause, identified by per-

centage assessments follows:

		Assessment %
A.	External to the Vessel:	
1.	Not Accidental:	
a.	Attack-Rifle, etc.	1
b.	Hijacking Attempt	0
c.	Barratry	0
2.	Accidental:	
a.	Lightning	0
b.	High Seas	0
c.	Grounding	0
d.	Collision	0
e.	Mines	0
B.	Internal on the Vessel:	
1.	Not Accidental:	
a.	Sabotage	1
b.	Suicide	1
c.	Hijacking Attempt	0
d.	Barratry	0
2.	Accidental:	
a.	Tank Cleaning (Washing/Gas Freeing/Testing/Drying)	85
b.	Cargo Transfer System	2
c.	Hogging and Sagging	2
d.	Engine Room - Fire Room Operation	3
C.	Unknowns	5
	Total	100

3. The Board concluded that the following contributed to this casualty:

a. Equipment used for cleaning (washing-gas freeing - testing and drying) of cargo tanks has, over a long period of time, evolved to a point of general acceptance in the tanker industry. However, there is nothing to prevent, and little to discourage, shipboard personnel from developing and utilizing equipment of their own design which could violate established tanker safety practices. The fresh water hose and nozzle used aboard the SS V. A. FOGG is a good example.

b. Associated with the above problem is the fact that shipboard personnel are free to use their own ingenuity and select any procedure for washing, gas freeing and cleaning

of cargo tanks. In the case of the SS V. A. FOGG the procedure followed was manifestly unsafe in several ways. Most significant was the fact that accurate determinations were not usually made of the explosive condition of the tanks, and the crew could work in the tanks while they were above the lower explosive limit.

c. The design of the SS V. A. FOGG for the carriage of benzene met Coast Guard regulations for the carriage of flammable and combustible liquids of Grade "B" and lower. Those regulations have served well for decades in the tanker carriage of conventional, aliphatic hydrocarbons such as gasoline, kerosine, heating oil and the like. But with the carriage of benzene in full shipload quantities, dangerous factors arise which are not addressed by the regulations. The first factor, and the one which caused the SS V. A. FOGG to suffer multiple explosions and suddenly sink after she first exploded, is the fact that empty benzene tanks, no matter how long they are secured or dogged down, will remain in the explosive range when the temperature is in the order of 12° to 61°F. Yet no one in management saw the need for, and Coast Guard regulations did not require, an inerting system or other safeguard for the tanks. When one tank on the SS V. A. FOGG exploded, other empty benzene tanks were caused to explode and the vessel sank like a rock while steaming ahead at full speed. The second factor concerns the toxicity of benzene. All hands were exposed at various times and under different circumstances to benzene vapors in harmful concentrations. Yet no one had seen fit that the SS V. A. FOGG be better equipped than a ship used for carrying conventional petroleum cargoes.

d. Turn around time on this trip was not conducive to safe washing, gas freeing and drying of the number of tanks to be so treated. A period of only about twelve hours was to have been allowed at sea to prepare tanks for cargoes to be loaded in Houston. During that time fourteen wing tanks would have to be washed and ventilated prior to entry by laborers hired to wipe twelve of the tanks dry. Two Weco/Hamer blinds (spectacle flanges) in the cargo tanks would have to be closed. In addition, five center tanks and three wing tanks would require washing and another center tank would have to be deballasted and washed.

e. The Company safety program was inadequate. The lack of emphasis by company officials and shipboard officers on a viable safety program resulted in little day to day training or concern. The program was almost nonexistent.

4. It is concluded that the most probable cause of the casualty was the ignition of explosive benzene vapors within

or without the cargo tanks while the vessel was at sea preparing tanks for loading cargo at Houston. The Board was unable to determine the source of ignition; however, the following facts, circumstances and conclusions are believed to provide a substantive explanation of the cause of the casualty.

a. The exact sequence of the tanks washed on board the vessel on the day of the casualty is not known; however, the Board has concluded, based upon evidence available and from the films of the wreckage that there is no reason to believe that the crew considered the tank washing and work to be done other than routine. Nothing in the evidence indicates that there was a departure from the routine established over the years on previous similar voyages with regard to sequence of tanks washed, methods and equipment employed; therefore, it is concluded that the tank washing began on the foredeck shortly after departing the sea buoy.

b. All cargo tanks, numbers 1 through 9, on the starboard side have been destroyed giving cause to believe that washing and gas freeing of these tanks had not yet been accomplished.

c. Number 1 port tank did not explode.

d. Damage to the number 2 port tank does not indicate that it was caused by an internal explosion.

e. A "red devil" pump was found in the number 3 port tank which indicates that the numbers 1, 2 and 4 port tanks had been washed and were in some stage of gas freeing.

f. The presence of the "red devil" pump and the fact that the number 3 port tank exploded leads to the belief that the tank had just been washed and work was being performed in that tank while it was in the explosive range.

g. The silhouette (shadow) effect observed on the foredeck strongly suggests that a fire ball swept diagonally across the deck from the vicinity of number 3 port tank towards the forecastle head.

h. The elapsed time from departure Freeport, allowing approximately thirty to forty minutes per tank, would have placed the men in and about the number 3 port tank. It is probable this was the area of most activity. There were persons, either crewmen or tank cleaners, working in or about nearby tanks as evidenced by tools, hoses and equipment found on both sides of the ship, forward of the amidships house and in the shelter deck.

i. The "red devil" portable pump subsequently removed from the number 3 port tank was a Chicago Pneumatic type, serial number 1714, fabricated of steel and as such was an ideal device for the collection and storage of an electric charge. No lanyard or line was found attached to the pump. The rubber air and discharge hoses, believed to have been used to lower the pump into the tank, contained no grounding wire and were effective insulators.

Based upon the foregoing it appears reasonable to conclude that the first ignition of benzene vapors on the SS V. A. FOGG could have occurred in the number 3 port tank. The tank had been recently washed and would have contained an electrically charged mist. The tank atmosphere was in the explosive range. An isolated conductor ("red devil" pump) was then lowered into the tank. Such are the conditions considered most propitious for the generation of an incendiary spark.

5. The Board has concluded that there were no survivors of this casualty and this together with other information adduced has led to the conclusion that the ignition, explosion and sinking occurred in rapid succession resulting in destruction of the vessel with loss of all hands. There were many factors which were considered supportive to those conclusions. Some significant ones follow:

a. The positions in which the main propulsion control levers in the engine room and the engine order telegraph lever in the wheelhouse were found by the divers; the steering control on the automatic pilot was set in automatic steering position; the general alarm switch in the wheelhouse was in the "off" position; the gyrocompass power failure alarm toggle switch was up; the steam smothering system and the fixed carbon dioxide fire fighting systems were intact and the major control valves were closed are indicative that there was no attempt to extinguish a fire or that there was insufficient time to do so. These facts are considered conclusive that the onset of the casualty was sudden and that it occurred while the vessel was steaming ahead at normal full speed. There is no indication that the crew was aware of, had prepared for, or that they anticipated any danger.

b. There is no evidence which indicates that the crew made any attempt to launch a lifeboat in the traditional manner or that anyone escaped the vessel by means of a life raft or any other lifesaving device. Those lifeboats found with the wreckage of the vessel were those which had been

stowed forward on each side of the amidship's house. One was found on the bottom, adrift and damaged, in the wreckage alongside the ship, outboard of its normal stowage place. The other, the port boat, was found crushed by a section of deck plating while still in its chocks. The positions of the davits at all boat stations, lend credence to the belief that none of the boats had been swung out.

c. The portable lifeboat radio transmitter was found intact, in its normal stowage place, still strapped to the bulkhead near the engineer's quarters in the after house. No radio transmissions were received by any vessel or shore station.

d. If by chance one or more of the crew had survived the massive detonations of the exploding tanks and the resultant shrapnel effect of airborne metal and had somehow gotten clear of the vessel without being drowned, it is very likely that he could not have survived the burning xylene. This xylene from the numbers 8 and 9 center cargo tanks ignited and was the primary source of the massive smoke cloud observed by the National Aeronautics Space Administration and Coast Guard pilots.

6. No misconduct, inattention to duty, negligence or willful violation of law on the part of any licensed or documented seaman was identified as causing this casualty.

7. No Coast Guard personnel or other representative or employee of the Federal Government was identified who caused this casualty.

8. The Board concluded that an industry - labor - government reorientation needs to be made concerning the shipment of benzene and other similar products in bulk in the marine mode, especially with respect to:

a. tank cleaning equipments used,
b. procedures employed for use of the equipment,
c. inerting and
d. training of personnel.

Although officers and crew aboard the SS V. A. FOGG were experienced and qualified to serve aboard conventional "petroleum" tank vessels, they disregarded and apparently were unaware of electrostatic effects that could cause ignition of benzene or other explosive vapors. It is believed they were unaware of the vapor pressure/temperature relationships of benzene that would cause their empty cargo tanks to be in the explosive range. And they evidently were unaware of safety precautions which properly should have been

taken to protect their health against toxic exposure to benzene and to benzene vapors. Such lack of knowledge or concern is regrettable. Company management, unions representing crewmembers, and Governmental agencies must take their share of responsibility for rectifying this unfortunate condition.

It would appear that the system which produces officers and seamen to man merchant vessels has to some degree failed to always produce a crew of the caliber needed to safely man tank vessels in chemical tanker trade. It is realized that the Coast Guard's licensing and certification function is a small but important part of this total system which includes inputs and influences, from many sources. However, it appears that the time has arrived to reassess the Coast Guard role in the system.

9.(3c) Laborers:

The five laborers aboard the vessel upon departing Freeport to clean tanks at sea were not members of the crew. They were carried as persons in addition to the crew. One of the laborers could not speak or understand English. His foreman would have to translate any command given in the English language.

The laborers held no Merchant Mariner's Documents issued by the Coast Guard. They reported aboard with various items of equipment, including "red devil" pumps, fresh air masks, and wiping rags. At various times they worked with and alongside the members of the deck department, under the supervision and control of the ship's officers. The laborers' extent of knowledge with respect to the proper use of their equipment, or with respect to tanker safety practices, would not necessarily have been a matter of first hand knowledge on the part of the ship's officers.

A level of highest risk in the operation of tank vessels normally occurs during the washing, gas freeing and cleaning of the cargo tanks. Aboard the SS V. A. FOGG, this level of risk was increased by the presence and utilization of the laborers.

By law every member of the crew of a merchant vessel such as the SS V. A. FOGG must be in possession of a U. S. Merchant Mariner's Document. Every person qualifying for a document must, among other things, state under oath that he will carry out the lawful orders of his superior officers on shipboard. At least sixty-five percent of the deck crew (exclusive of licensed officers and apprentices) must be of a rating not less than Able Seaman. And at least seventy-

five percent of the crew, in each department, must be able to understand any order given by the officers of the vessel.

Had the above criteria been applied in the employment of the five laborers, all would have had Merchant Mariners' Documents and would have been subject to disciplinary action by the Coast Guard in the case of failure to properly perform their duties. If treated as members of a deck crew required aboard for tank cleaning voyage, at least three of the five would have been qualified as Able Seamen (which includes the ability to speak and understand English). All would have had a clear understanding of their duty to obey lawful commands.

It is concluded that greater safety in the cleaning of tanks aboard tank vessels at sea would be achieved by the employment of merchant seamen as members of the crew, rather than by the employment of laborers as persons in addition to the crew.

10.(3c) Death Certificates:

Next of kin involved with insurance, social security, property settlement and like actions need a Death Certificate or similar document to prove that a person is dead. There is resistance by officials to accept as evidence of death a letter signed by a Coast Guard Officer which states that a person is missing and presumed dead. The Board is aware that this situation has presented a real hardship to some of the next of kin of the crew of the SS V. A. FOGG.

11.(4) Weather Data:

The air and sea temperatures that prevailed prior to the casualty were significant with respect to the establishment of explosive vapors inside the cargo tanks. Weather otherwise played no part in this casualty.

12.(5a) Inerting:

The SS V. A. FOGG sank as a result of multiple explosions in sixteen wing tanks (of 18) and at least two center tanks (of 9). Explosion in one tank set off the explosions in the other tanks.

The SS V. A. FOGG was not equipped with an inerting system for the cargo tanks. Such equipment, had it been provided and properly used, might or might not have prevented an initial explosion in one tank. However, inerting would have reduced the number of tanks that exploded, thereby keeping the vessel afloat long enough for survivors of

the first blast, if there were any, to combat the problem, get off a distress message or abandon ship if indicated.

13.(5b) Coppus Steam Turbines:

The history of mechanical difficulties experienced with the Coppus Steam Turbines Model TFV221 on the deep well pumps on the SS V. A. FOGG warrants further study of their suitability for installation on tank vessels.

14.(5b) Deep Well Pump Drain:

The method employed to drain the sumps of deep well pumps introduced an added risk to the vessel and crew. The requirement for personnel entry into a tank containing an explosive and toxic atmosphere can and should be avoided.

15.(5c) Stack Emmissions:

The Board considered that sparks or other incandescent materials emitted from the stack were remotely possible but unlikely sources of ignition, and therefore not contributory to the casualty. However, there is evidence which indicates that on several occasions on previous voyages, malfunctions of equipment in the machinery spaces, particularly the boiler equipment, resulted in emissions of incandescent or incendive materials from the stack. In most cases the emissions were basically smoke.

The Board found no evidence which indicates that the boilers sustained a malfunction or derangement which might have caused sparks or other incendiary material to be emitted from the stack on 1 February. Evidence available from photographs and video tape reveal no damage to burner fronts, boiler casings, uptakes or steam piping which could be attributed to any rupture of the boiler casings or pressure parts due to failure or fire. Damage observed was assessed as damage incurred due to shock of explosions external to the machinery spaces and that which was caused by the rapid ingress of large amounts of water into those spaces.

The Board believes that had there been emissions of incendive materials from the stack on the day of the casualty it is very likely that they would have carried well clear of the ship due to its headway and the velocity and direction of prevailing winds. Speed of the ship was estimated at 12.3 knots. This was derived from calculation of the distance from the Freeport sea buoy to the location of the sunken vessel, 30.7 nautical miles, and the time of departure from Freeport sea buoy and the estimated time of the casualty, 1330 P. M. local time and 1545 local time.

The distance was measured along a course line of 127, which the Board believes was the approximate course traveled by the vessel on the day of the incident.

With the vessel's course of 127° and speed of 12.3 knots and with a true wind 000°T from the North at 8 knots, the relative wind would have been 3.19 at 10 knots, or broad on the port bow.

16.(5c) Blowing Tubes:

The possibility that stack emissions from blowing boiler tubes caused or contributed to this casualty is considered remote. Testimony of former crewmembers who served on the vessel on previous voyages has established that it was long-standing practice on the vessel for the second assistant engineer to blow boiler tubes on the four to eight watches at sea. It was also done shortly after departure from the sea buoy, particularly, if the vessel had been in port for several days. A prerequisite to blowing tubes was obtaining permission of the deck officer on watch. Granting permission was based upon conditions prevailing on deck at the time. Considerations which, on past occasions, precluded or delayed blowing tubes were: possible gas hazard due to tank washing and ventilation of open cargo tanks; wrong direction and force of the prevailing wind which would prevent soot or smoke emissions from carrying well clear of the ship.

It is believed unlikely that boiler tubes were blown at the estimated time of the casualty, 1545 local time, because the engineer responsible for this task was not normally due on watch until 1600. Since the vessel had been in port for two days, the task was more than likely done at about 1330 or soon after the ship was clear of the sea buoy. Further, it is unlikely that the Mate on watch would grant permission to blow tubes at 1545 knowing that tank washing was underway even though the wind direction and velocity were favorable.

17.(5c) Retrofit:

The modification or automation of the vessel's main boiler control equipment is not considered to have caused or contributed to this casualty. However, the Board offers several comments with regard to modification of older vessels solely for the purpose of achieving a reduction in crew. It is believed that there was no adequate trial data recorded or compiled relative to the plant's performance, after departure from the shipyard.

It is also believed that the trial or test runs were of insufficient duration to adequately determine that this sub-

stantially altered propulsion plant was capable of operating for sustained periods with ample margin of safety. While meeting some of the major technical aspects or the current recommended directives on automation of main boilers, the installation lacked some important necessary features and did not comply with the intent of these directives. This conclusion is supported by: the vessel's lack of a call bell system; the reduction in speed of response to engine orders; and an apparent loss of reliability of the propulsion plant due to the frequency of power losses.

18.(5f) Non-Sparking Tools:

Current tank vessel regulations do not require non-sparking tools be carried on tank vessels. The Board concluded there is considerable confusion among seamen and other persons in the tanker industry who gave testimony before this Board as to the status of and need for non-sparking tools on tank vessels.

19.(5f) Tools:

Considering the important part tools and portable pumps play in the tank washing and gas freeing process and the consequences likely to ensue should they be improperly used in explosive environments, the Board has concluded that there is a need for the Coast Guard and industry to examine the suitability of tools, equipment, and methods used in the gas freeing process on tank vessels.

20.(6e) Lifeboat Drills:

(a) Lifeboat drills were not held in strict compliance with Coast Guard regulations. The drills were perfunctory and were not accomplished precisely as though an emergency did exist. All equipments required by law were not determined to be in proper working order for immediate use. This extent of noncompliance with Coast Guard regulations justified further investigation under the provisions of R. S. 4450 as amended (46 USC 239), looking to a suspension or revocation of license of the responsible officer or officers who served on the SS V. A. FOGG prior to her loss.

(b) Discovery of the manner in which lifeboat drills were conducted aboard the SS V. A. FOGG gives cause to inquire into the manner in which drills are held on other tank vessels.

(c) To be in compliance with Coast Guard regulations, lifeboat drills must be accompanied by lowering of every lifeboat at least once every three months, if practicable

and reasonable. One seaman who served aboard the SS V. A. FOGG had never been in a lifeboat during his ten years at sea, most of which was acquired aboard tank vessels. This man's complete lack of experience in a lifeboat gives cause to inquire into the degree of safety being achieved by a lifeboat lowering requirement (46 CFR 35.10-5e) that is qualified by the words "if practicable and reasonable".

21.(9b) Tank Washing:

The vessel did not carry enough fresh water to wash each of the fourteen tanks for periods of thirty to forty-five minutes. It is considered more likely that each tank was washed for considerably less time, possibly less than fifteen minutes, leaving high percentages of residual liquid cargo in the tanks. This would result in a less than adequate effort. Considering the small amounts of water used in this fifteen minute period, the large capacity of the deep well pumps and the problems attendant with the use of these pumps for removal of small quantities of water, it is likely that for some washed tanks the removal of slops (wash water and residual product) could have been by use of the air operated "red devil" pumps.

22.(10) Cofferdams:

The mixing of water and solvent in the forward cofferdam on previous voyages was in violation of the admeasurement regulations. It is concluded, however, that such procedure was unrelated to the casualty and that the objectives of the Board would not be served by further development of this aspect.

23.(10) Clothing:

Another possible causal factor, among the many considered is that there were no prohibitions by any responsible person, on board ship or ashore, against the wearing of ordinary shoes, the carriage of keys, matches, knives, cigarette lighters or other objects in pockets of clothing by crew or tank cleaners when working in or about the cargo tanks. Nor were there any recommendations or requirements as to the type of shoes or clothing to be worn while performing this work.

24.(11b) Tank Washing, Gas Freeing and Drying:

The following conclusions make reference to tank washing procedures and atmosphere control as set forth on pages 13 and 14 of the "Interim Report Tanker Accident Study Committee" dated 30 November 1971 from the American Petroleum Institute.

a. "Vessels operating with tanks in the uncontrolled atmosphere condition must take extra precautions in eliminating ignition sources." The Board concludes that extra precautions were not taken on 1 February 1972 on the SS V. A. FOGG to eliminate ignition sources.

b. "After discharge of cargo and upon completion of ballasting, all tank openings not in use should be closed. When tank washing is commenced only those tank openings being used should be opened". The Board concludes this was not done on the SS V. A. FOGG. Substantially all tank hatches were opened up well before the wash down, gas freeing operation started.

c. "The electrical continuity of all tank washing hose bonding cables must be checked for electrical conductivity on every occasion before use." The Board concludes this was not done on the SS V. A. FOGG.

d. "Clean ambient temperature sea water should be used with portable washing machines". The Board concludes that this was not done on the SS V. A. FOGG in that they used fresh water for tank washing.

e. "Ungrounded objects, regardless of the type of material, should not be introduced into the tank at any time when a mist of water vapor cloud might exist, unless enclosed within a standpipe or sounding tube which is built into the ship. This restriction includes sounding rods, ullage tapes, ungrounded gas sampling hoses and canvas chutes for portable blowers. After washing has stopped, the waiting time for the introduction of isolated objects is five hours with natural ventilation, and one hour with mechanical ventilation." The Board concludes that, on the contrary, an ungrounded object (portable pump) was introduced into the tank vapor mist and that the prescribed venting period was not observed.

f. The Board concluded that the tanks were not gas free at all times when men and "red devils" were placed into the tank. Furthermore, after deep well pumping had been finished there were still substantial quantities of product-water mixture in the pump that had to be drained into a tank.

g. Summary Conclusion:

The procedures used on the SS V. A. FOGG on 1 February 1972 to clean tanks varied considerably from those practices recommended by the American Petroleum Institute for cleaning tanks.

25.(11a) Slop Discharge:

There was conflict in the testimony of former crewmembers as to how slops from the tanks served by the deep well pumps were handled. Some persons recalled that slops were pumped into and held in the number 9 wing tanks and pumped overboard when the vessel was well at sea. Others stated that it was practice to discharge slops from the amidship's manifold to the open deck allowing it to flow overboard through the deck scuppers. There were others who remembered that an aluminum chute bolted to the amidship's manifold directed the slops overboard at the side of the ship. Because of the time element involved and the fact that the chute was found intact after the casualty, in the stowage space under the amidship's house, it is believed that the benzene-water slops were discharged from the amidship's manifold without a chute where they flowed across and aft on the open deck due to the 13 foot trim by the stern, before flowing over the side. This method of discharging slops exposed the vessel to an unnecessary hazard at a time when the level of risk was highest.

Benzene-water slops, if discharged overboard while washing tanks, should be discharged through an overboard fitting below or near the waterline.

26.(11c) Combustible Gas Indicators:

The use of a combustible gas indicator by knowledgeable persons is a satisfactory method for determining the presence of a combustible atmosphere within a tank or compartment after the carriage of flammable or combustible products. Toxic properties of atmospheres within a cargo tank or compartment are not determined with a combustible gas indicator.

The reliance upon sense of smell as the primary or sole method to determine whether a tank was safe to enter and to work in was a poor practice and is believed to have been a contributing cause of this casualty. The casualty might have been prevented, had it been the practice on board to adhere rigidly to the use of a combustible gas indicator in any instance before men were to enter or equipment be placed in a cargo tank.

27.(12) Exposure to Benzene:

This Board has found that the crewmembers on the SS V. A. FOGG were repeatedly exposed to benzene vapors in harmful concentrations. Exposure was caused by fumes emit-

ted from several sources while washing and gas freeing cargo tanks. Exposure also occurred when fumes were emitted from vents and open ullage openings while loading ballast or cargo. The SS V. A. FOGG was certificated for the carriage of grade "B" and lower flammable and combustible liquids and its cargo tank venting system was configured in accordance with applicable regulations. In view of the above, it is concluded that there is a need for an amendment to the tank vessel regulations which would correct this apparent deficiency and which would control this source of noxious fumes.

28.(12) Tank Vessel Design:

The carriage of benzene on a single skinned tank vessel having conventional pumping and piping systems can pose many unnecessary hazards whenever that vessel's tanks are used interchangeably with other products, as was done on the SS V. A. FOGG. Tank entry as frequently required aboard that vessel could well have been avoided aboard a vessel of more sophisticated design. For example, there really should be no need to design a vessel with cargo lines that require tank entry to open or close spectacle flanges (Weco/Hamer blinds). There also should be no need to design a vessel which requires the utilization of portable pumps to remove water that remains after washing the tanks. Furthermore, if tanks must be wiped dry before loading, consideration should be given to the advantages of having smooth internal surfaces with external strength members.

29.(14) Radio Frequency Induced Arcs:

Although experts have determined that incendive sparking could, under certain circumstances, result from radio induced current, there is no reason to believe that this phenomenon occurred on board the vessel or that such phenomena caused or contributed to this casualty. The Board was not able to positively establish that the C.W. radio equipment on board the SS V. A. FOGG was or was not in use at the time of or just before the casualty. However, the Board has concluded that the probability that this equipment was in use is remote for several reasons. These include: past practices of the company officials and shipboard personnel was to use radio-telephone as a primary means of communication when the vessel was at sea on tank cleaning voyages; the radio operator would not have been transmitting during the silent period from 1545 to 1548 unless there were an emergency; and there is no evidence that any messages, voice or C.W. were received from the SS V. A. FOGG after her departure from Freeport, Texas. Furthermore, it is believed that the casualty occurred with such suddenness it prevented any time to transmit a distress message.

Divers found the radio-telephone switch in the "on" position with the volume switch turned up one fourth turn. These are believed to be the normal standby settings. Damage to the radio room precluded any determination based upon settings of switches, antenna or other apparatus in the radio room.

30.(14) Search:

The air and surface unit searches carried out appear to have been appropriate searches with available resources. The Board concurs that the search on 1 February by a UF 16 was more appropriate than attempting a helicopter search that distance offshore at that time of day with the visibility and weather conditions which then existed.

Because of the severe damage, sudden sinkage, and fire which occurred, it is beieved that no property or lives could have been saved by any Coast Guard search and rescue efforts.

The wreck of the SS V. A. FOGG presented an unknown hazard to navigation during the time it remained undiscovered in the relatively shallow waters of the Continental Shelf off Galveston. However, had there been available to the search vessels and aircraft underwater detection gear designed for and capable of locating a large underwater object, it is probable that the wreck would have been located within the first few days of the search.

31.(14) Emergency Positioning Indicating Radio Beacon (EPIRB):

The vessel was reported missing on 2 February, one day after the smoke cloud was sighted. The wreck was located on 12 February in 100 feet of water. During the interval from 1 to 12 February the area was searched by numerous aircraft and vessels. The Board is aware that there have been previous recommendations by other Marine Boards of Investigation and by the National Transportation Safety Board, that some form of emergency position indicating radio beacon be adopted as a piece of ship's equipment. The Board is also aware that good results have been experienced in those cases where the devices have been used. The device probably would not have led to the saving of life or property in this case; however, it most likely would have aided in prompt location of the wreckage, thereby shortening the expensive search time.

32.(16) The Secretary of Treasury's Committee on Tanker Hazards Final Report of 14 August 1963:

Professor Seward in his report makes a number of re-

commendations, particularly with concern to the training of personnel assigned to tankers. Virtually all of these recommendations would apply to the management of this vessel in that the SS V. A. FOGG and its owners did not carry out such training of the men assigned.

Recommendations

1. Death Certificates:

That the Coast Guard issue a Death Certificate, or similar document, based upon an investigation of a casualty at sea by a Marine Board or Investigating Officer of the Coast Guard. A Board or an investigator's conclusion, that a person is missing and presumed dead, could be relayed to Coast Guard Headquarters, even in advance of final completion of the investigation or Board's report and could be used as the basis for issuing a Death Certificate.

2. Coppus Steam Turbines:

That the suitability of Coppus steam turbines for driving deep well pumps be reviewed by the Coast Guard to verify that they meet minimum safety standards for use aboard tank vessels.

3. Boiler Retrofit:

That the Coast Guard undertake a detailed review of the applicability of current directives for automation or "Retrofit" of boiler combustion controls and burner management systems on older vessels.

4. Non-Sparking Tools:

That a Navigation and Vessel Inspection Circular or some other means be utilized by the Coast Guard to inform seamen and operators of tank vessels of the current evaluation concerning the use or nonuse of non-sparking tools on tank vessels.

5. Safety Information:

There are available to the industry several recent studies which have been directed toward improving the safety of tank washing and gas freeing in tankers. There are other publications which contain good information and guidelines which would be of great value to the seamen on the ships who perform the work. As in the case of the SS V. A. FOGG, much of this information, although it might be readily available to shore staffs or companies, does not filter down to the seamen on board the tankships. It is therefore recommended that the Coast Guard take a more active role in the timely and broad dissemination of tanker safety practices, such as those developed in the 30 November 1971 Interim Report of the API Tanker Accident Study Committee.

6. Lifeboat Drills:

a. That further investigation under the provisions of R. S. 4450 as amended (46 USC 239), be initiated in the matter of Captain Reuben H. McLAURIN, and any other officer similarly involved, for failure to hold lifeboat drills aboard the SS V. A. FOGG in strict compliance with Coast Guard regulations.

b. That the Coast Guard review existing practices and make detailed inquiry into the manner in which lifeboat drills are being held aboard tank vessels, to insure that the drills are in fact being held in strict compliance with the regulations.

c. That the Coast Guard review and make detailed study of existing practices aboard tank vessels to ascertain how frequently lifeboats are lowered and whether or not undue resort is made to the provision "if practicable and reasonable" which appears in 46 CFR 35.10-5(e).

7. Tank Washing, Gas Freeing and Drying:

That the Coast Guard together with other interested government agencies and representatives of the tanker industry study the inerting, tank washing and gas freeing methods now in use in the industry, looking toward formulation of minimum standards and suggested procedures. The study should be broad in its scope and cover the wide range of products and chemicals moving in bulk on U. S. tank vessels.

8. Equipment List:

That tools, hoses and other equipment or devices used in the tank inerting, washing and gas freeing process be given special attention looking toward a determination of the need and feasibility for those items to be tested and examined, and if found safe to use, approved and included in the List of Approved Equipment for shipboard use.

9. Coast Guard Organization:

That the Coast Guard should establish in the Office of Merchant Marine Safety an organizational branch, a focal point charged with responsibilities as concerns:

a. Tank cleaning (washing - gas freeing - drying).

b. Inerting of tanks.

c. Testing and monitoring of tank atmospheres.

This branch would be concerned with design of equipments, and procedures for their use aboard tank vessels carrying a wide range of products and chemicals in bulk.

This branch would be the Department of Transportation and Coast Guard interface with labor, industry, U. S. Governmental agencies and international organization on these subjects.

10. Coast Guard Research and Development Program:

That the Research and Development Program of the Coast Guard include work on:

a. Tank cleaning (washing - gas freeing - testing - drying) so as to improve: (1) safety of cleaning equipment; (2) procedures for cleaning equipment use; and (3) air and water pollution control over tank wastes.

b. Inerting of tanks - equipments and procedures for usage with regard to tanks carrying specific chemicals found moving in bulk on our waterways.

c. Ignition control - emphasis on static electricity phenomena is indicated.

d. Tank atmosphere testing and monitoring equipment.

The Board recommends that the Coast Guard Fire Test Facility at Mobile, Alabama, operated by the U. S. Coast Guard Office of Research and Development, be made available to industry and the academic community for research in the above four areas.

11. Tank Atmosphere Testing:

That existing tank vessel regulations which require that compartments or tanks be inspected and found safe prior to undertaking alterations, repairs or hot work be expanded to include operations such as tank cleaning, changing of spectacle blinds and utilization of portable equipment.

That study be given to the need for carriage of toxic analizers aboard tank vessels.

That tank vessel regulations be amended to require that the combustible gas indicator, and the toxic analizer, whenever a part of vessel's required equipment, be maintained in good operating condition. The regulations should further

require an annual calibration and testing of the instruments by an approved testing facility.

12. Cargo Tank Venting:

That venting requirements in the tank vessel regulations be amended for vessels in benzene service. That new tank vessels or tank vessels altered for the carriage of benzene be fitted with closed venting systems and remote reading ullage or gaging systems. Pending promulgation of changes in the regulations, consideration should be given to a requirement that all existing tank vessels now in benzene service be fitted with those cargo tank vents required for tank vessels certificated for the carriage of grade "A" liquids.

13. Grounding of Tank Washing and Venting Equipment:

That the Coast Guard issue a Notice to Mariners to remind seamen who serve aboard tank vessels of the need for grounding tank washing and tank venting equipments. This is especially important with respect to portable tank washing devices as used on the SS V. A. FOGG. It would also be important should someone decide to use air instead of saturated steam to power a plywood mounted blower-exhauster.

14. Search:

That the Coast Guard's capability for search and rescue be expanded by the provision of suitably designed equipment which can be expected to locate large metallic objects below the surface of the water.

15. Emergency Positioning Indicating Radio Beacon (EPIRB):

That the Coast Guard accelerate research and development efforts in the field of EPIRB devices, looking toward an increase in effectiveness in detecting and locating foundered vessels and rescue of those persons, passengers or crew who might have survived a casualty.

16. Sonar Beacon:

That the Coast Guard initiate a study of the effectiveness and practicality of sonar beacon devices for use in locating and marking sunken vessels. As a result of a study supported by the Coast Guard, a band of underwater frequencies was recommended for dedication to search and rescue purposes. It is recommended that the Coast Guard initiate appropriate measures to achieve that dedication.

17. Training:

That union training schools and U. S. Maritime Administration Schools responsible for training of our U. S. Merchant Marine personnel be encouraged by the Coast Guard to include in their curriculum a course of study on chemicals being moved in bulk on our waterways. Specific information on toxicity and explosive nature of these cargoes should be provided the students. Company training of its personnel should include the above factors with special emphasis on the products being carried by vessels of that company.

18. Tank Cleaners:

That the Coast Guard in the issuance of Certificates of Inspection prescribe that all persons who serve aboard ship for the purpose of cleaning tanks at sea be merchant seamen, and that they be a part of the required deck crew subject to the sixty-five percent requirement for Able Seamen.

19. Licensing and Certification:

That the Coast Guard initiate a comprehensive review of the requirements for licensing and certificating of officers and men to insure that those seamen who serve aboard chemical tankers have the requisite knowledge of the physical, chemical and toxiological properties of cargoes being carried.

O. R. SMEDER

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Chairman

Captain C. T. NEWMAN, USCG,
Member

Commander M. E. WELSH, USCG,
Member

Commander W. E. WHALEY, JR., USCG
Member and Recorder